



Licensed

TO KILL

How the **nuclear power industry** destroys endangered marine wildlife and ocean habitat to save money



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Executive Summary

Marine life in all forms, from endangered manatees and sea turtles to essential microscopic organisms, is being harmed and killed by once-through cooling systems, used to remove waste heat at nuclear power stations. A typical once-through cooling system draws into each reactor unit more than a billion gallons of water a day, 500,000 gallons a minute. After cycling through the power generating station, the heated water is discharged at temperatures up to 25 degrees F hotter than the water into which it flows. A total of 59 out of the 103 U.S. reactor units rely on this system, either exclusively or in conjunction with closed cycle canals or cooling towers.

This report examines the toll the once-through cooling intake and discharge system takes on marine biodiversity around nuclear plants, including sea turtles and other endangered marine animals. The report takes into account the already severe problems affecting the health of U.S. oceans and waterways and the impacts of nuclear power plant operation within the context of this crisis. The authors review the cumulative impact of marine ecosystem destruction by coastal nuclear reactors as well as the local effect on marine life in the vicinity of the plant. Particular attention is given to the effectiveness of regulatory oversight and the adherence to and implementation of the federal Clean Water Act (CWA), the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA).

Power Plant Systems and Alternatives

Nuclear power electrical generating stations use the tremendous heat resulting from the controlled splitting of the atom to boil water to generate steam for powering electrical turbogenerators. Atomic reactors produce much more heat in the fission process than is needed to generate electricity. For each unit of electrical energy generated, two units of heat energy are released into the environment. To operate a nuclear power station efficiently, this waste heat must be removed.

Electric utilities use a variety of methods to remove waste heat from their nuclear reactors, but most companies rely on the once-through cooling system. The system transfers the heat load to the intake water and discharges the heated water back into the environment, using the same body of water as a *heat sink* to absorb and dissipate the excess heat generated by the system. In contrast, operators using cooling towers draw in a lowered water intake of about 20,000 gallons a minute, reducing the potential for damage to marine life sucked into the nuclear plant.

Cooling towers also eliminate the need to discharge large volumes of heated water into the water source and the resulting damage to the marine environment in the discharge area.

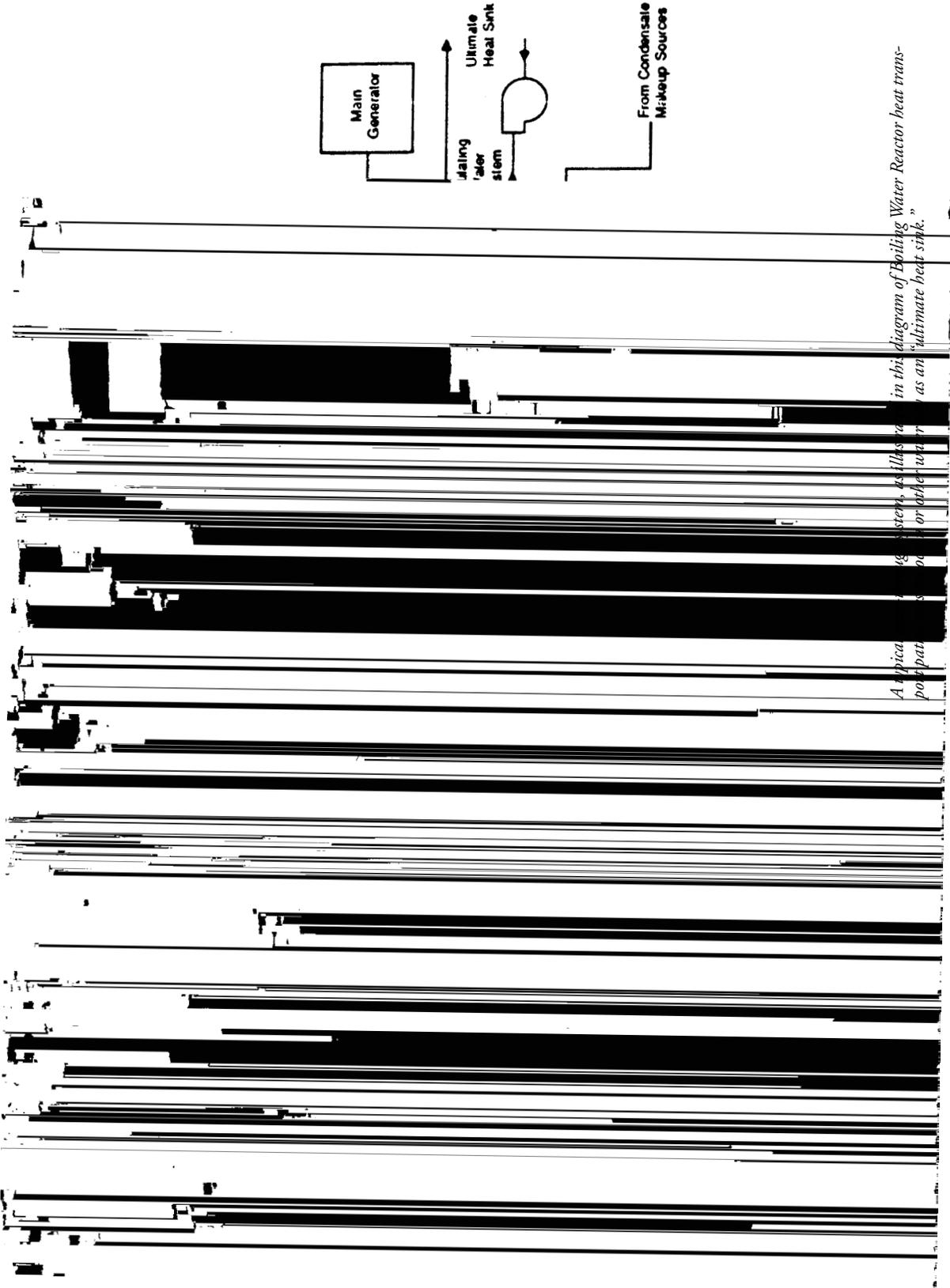
Overall Harmful Effects of the Once-Through System

The environmental impact of diverting more than a billion gallons of water per unit per day from a water source such as an ocean or estuary, heating it up, then discharging it at temperatures up to 25 degrees F higher than the surrounding water has been shown to cause significant damage. Not only are marine animals “entrained” or “impinged” by the intake system, but billions of smaller marine organisms, essential to the food web, are also sucked into the reactor operating system and largely destroyed in



The damage to endangered species, marine life and habitat, by once-through coolant reactors such as those at St. Lucie, pictured, is catastrophic and in some cases potentially irreversible.

Normal BWR Heat Transport Paths During Power Operation



A typical BWR system, as illustrated in this diagram of Boiling Water Reactor heat transport paths, is often referred to as an "ultimate heat sink."

this process. *Entrainment* involves the drawing in of marine life through an intake tunnel, pipe, or canal at a velocity the marine animals cannot resist. Once drawn in, they are subject to *impingement*, becoming trapped against “prevention devices” such as screens, racks, bars, and barrier nets. Larger animals may then drown or suffocate after becoming impinged.

Smaller fish and other organisms may be entrained through the entire reactor system and are often scalded by the heated water before being discharged into the waterway. Others, pulverized by the reactor condenser system, emerge as sediment that clouds the water around the discharge area, often blocking light from the ocean floor. The resulting shadow effect kills plant and animal life around reactor discharge systems by curtailing the light and oxygen they need to survive.

Regulatory Oversight and Mitigation

The lack of oversight by federal agencies authorized to protect the marine environment from unfettered industrial development and pollution has alarmed industry watchdog and animal protection organizations. Ecological concerns include the destruction of marine species and their surrounding habitat, particularly the killing and capturing of endangered species through the routine operation of atomic reactors.

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Under the present system, the nuclear industry’s needs almost always prevail over the interests of marine life. The use of technology that is least harmful and polluting to the environment is a prerequisite of the CWA. However, installation of cooling towers, unquestionably an improvement over once-through cooling systems, has been selectively enforced at atomic reactor sites and resisted by utilities hoping to avoid the expense. The U.S. Environmental Protection Agency (EPA), responsible for enforcing compliance with intake and discharge permits at reactors under the terms of the CWA, has largely failed to establish national performance standards. This failure has resulted in at least one lawsuit to date, forcing EPA to revise its national performance standards for both new and existing power plants. This process is ongoing.

The U.S. Nuclear Regulatory Commission (NRC) is entrusted with the enforcement of licensee regulations under the Endangered Species Act but frequently acts instead as an advocate for the nuclear industry. The NRC often persuades the National Marine Fisheries Service (NMFS), the agency that governs the protection of most marine animals, to back away from more stringent actions that would minimize destruction of these animals and their habitat. To save the industry money, requirements that would protect marine life and habitat are weakened, watered down, or done away with entirely at nuclear reactors.

Instead of applying sanctions when a nuclear plant kills more than its allowed quota of an endangered species, as laid out in the *incidental take statement* issued by NMFS, NRC acts on behalf of the plant owner to secure a larger quota. If a plant exceeds its allowed take limit, it must renegotiate a new limit. This is known as *reinitiation of consultation* under ESA Section 7. The utility must first prepare a *biological assessment* of the problem. After discussion with NMFS and NRC, and an NMFS draft response, NMFS issues its final *biological opinion*, setting out the new take limits and establishing the new incidental take statement. NRC is invariably an advocate for the utility during this process. For example, at reactors where sea turtles are captured, NRC consistently encourages NMFS to withdraw from its biological opinion most of the requirements that are important to the long-term survival of the species such as habitat studies, tissue sampling, video studies, and comprehensive animal necropsies. NRC also supports industry attempts to raise the limit on the number of animals that can be killed or captured during reactor operation.

Falsification and False Promises

State water and wildlife authorities also fall prey to nuclear industry pressure tactics. Regulators are kept in the dark and legally intimidated by the nuclear industry in its efforts to avoid or dramatically reduce penalties and mitigation requirements for the harmful effects of the once-through cooling system. This occurs even after proof that an offending utility has deliberately withheld or misrepresented vital but unfavorable data.

For example, the California utility, Pacific Gas & Electric (PG&E), for many years, provided state water authorities with skewed data on its Diablo Canyon nuclear power station. The data showed that the plant's intake of billions of gallons of water a day did very little harm to surrounding marine life. PG&E's conclusions were based on the unscientific formula that the amount of sea life drawn into the system at the intake port could be accurately measured by the amount of small fish and other organisms at the outflow of the cooling system.

In the spring of 2000, Diablo Canyon's operators were discovered to have withheld information from environmental regulators for two decades revealing the true effect of the reactor's hot water discharges into the coastal waters off Diablo Cove and miles beyond. The concealed data included infrared images indicating more extensive thermal plume impact zones than previously admitted and time-series photographs showing the progressive deterioration of biologically important marine habitat in coastal waters around the reactor. The damage was catastrophic to the indigenous marine life community, including the near obliteration of the already threatened black and red abalone populations. The concealed findings also revealed up to a 90 percent destruction of many varieties of sea life as they passed through Diablo Canyon's cooling system. These findings had never been reported to state or federal agencies.

State water authorities viewed the escalating damage as sufficiently severe to press for a cease and desist order against the utility's previously accepted levels of waste heat discharges. A state cease and desist order would have effectively halted, or reduced the thermal discharges, or reduced their temperature, and imposed severe fines on the utility for continued heat pollution that threatened marine habitat and its indigenous species.

However, the order was undermined by the utility. Despite publicly documented evidence, and even evidence of its own, PG&E argued that no mitigation action was needed. Using a threat to outspend environmental regulators in legal actions appealing the cease and desist order, PG&E forced the authorities to back down. Instead, the state regulators have proposed to accept a settlement that ignores the reactor's ongoing thermal damage and includes a cash pay-off of just \$4.5 million for vaguely worded

marine species protection measures while simultaneously reducing the scope of monitoring the harmful effects of the Diablo Canyon cooling system. This regulatory retreat in effect allows the utility to continue its business-as-usual practices while sacrificing an entire indigenous marine life community as the cost of marketing electricity.

Edison quickly reneged on its promise and began its campaign to avoid any protective obligations.

Nuclear utilities make promises during licensing they have no intention of fulfilling once their reactors begin operation. Units 2 and 3 at the San Onofre Nuclear Generating Station (SONGS) near San Diego, CA, were permitted to come on line, based on the owner's submission to a comprehensive environmental impact study. The utility, Southern California Edison (Edison), agreed at the time to compensate fully for any environmental damage subsequently found by the study.

When findings suggested that the operation of San Onofre had caused substantial damage to the marine environment, however, Edison quickly reneged on its promise and began its campaign to avoid any protective obligations. Since the study's publication in 1989, Edison has done little but dispute and disregard the recommended actions. Despite the California Coastal Commission's July 1991 instruction to complete a 150-acre wetlands restoration and build a 300-acre artificial reef near the plant, Edison has, to date, spent a mere \$2.7 million in the construction of a 22.5 acre reef. This is a paltry sum when compared to the utility's 1999 earnings of \$484 million from a \$1.5 billion net cash flow, as reported to the Securities and Exchange Commission.

Species-Specific Harmful Effects: Sea Turtles

Four species of endangered and one threatened species of sea turtle present in U.S. coastal waters are harmed and killed by nuclear power station operations. Loggerhead, green, and Kemp's ridley sea turtles are the most common victims at nuclear reactors. Leatherback and hawksbill sea turtles have also been taken on rare occasions. Worldwide, the Kemp's ridley is the most severely endangered sea turtle species, although the Pacific leatherback is currently at the most immediate risk of extinction.

Sea turtles are entrained into the large-diameter coolant intake pipes used by coastal reactors. A 1990 National Academy of Sciences (NAS) study, "Decline of Sea Turtles, Causes and Prevention," examined the impacts on worldwide sea turtle populations and recommended protective measures to prevent their extinction. The academy, in its investigation of power plant impacts, found that death and injury can occur in transit through a reactor's once-through intake pipe such as the one employed at the St. Lucie plant in Florida. However, since 1985, no utility has attributed sea turtle injury or mortality at a nuclear reactor site to transit through an intake pipe, although sea turtles continue to be entrained through the St. Lucie pipe in large numbers.

Sea turtles are also impinged by the force of the intake water and become lodged on velocity cap structures at the intake entrance or farther downstream on barrier nets, underwater deterrent systems, and, ultimately, against the power station's metal grate trash racks. Mortality reports ascribe death to drowning, but some experts clarify this as suffocation as necropsies usually show no water present in the lungs of dead sea turtles at nuclear plants.

Utility operators often refuse to admit responsibility for the death and injury of sea turtles, blaming prior injuries, including boat collisions and shark attacks.

Utility operators often refuse to admit responsibility for the death and injury of sea turtles, blaming prior injuries, including boat collisions and shark attacks. By making this distinction between sea turtles directly killed or injured by reactor operations and those allegedly suffering prior injuries, utilities can effectively increase their kill and capture limits. For example, if a reactor is given a lethal "take" limit of 10 sea turtles a year and makes its own judgment about which animals were killed due to plant operation, "noncausal" lethal takes can be omitted from the limits to increase the amount of authorized kills at the reactor.

To avoid costly protective actions, nuclear utilities dismiss their deadly role as minuscule. However, every sea turtle killed at a nuclear reactor has an essential part to play in the species' survival. Sea turtles harmed by nuclear reactors range from juveniles and subadults to adults all of whom have already survived the enormous attrition from predators suffered by hatchlings. Scientists and sea turtle experts agree that removing these viable members of the population could have serious consequences. Egg-bearing females are particularly vulnerable, especially when habitual nesting beaches are occupied by a nuclear reactor such as occurs in Florida at the St. Lucie station. Furthermore, evidence shows that sea turtles are lured into dangerous proximity of reactors by the artificially warmed

waters, the resulting abundance of favored prey, and the resemblance of the intake structures to reefs, a desirable feeding and resting place. This puts sea turtles in danger of entrainment through intake structures and of being trapped by colder waters should they linger too long in the artificial environment created by the reactor discharge system.

Species-Specific Harmful Effects: Fish, Fish Larvae, and the Marine Habitat

Fish, fish larvae, and fish eggs are harmed and destroyed upon entering the flow of reactor cooling water where they are sucked into and impinged on the water intake screens. These ecologically essential life forms are then stressed by the mechanical, chemical, and thermal impacts of the operation of the once-through cooling system. Smaller fish, fish larvae, spawn, and a tremendous volume of other marine organisms are daily drawn deeper inside the reactor coolant system where up to 95 percent are scalded and discharged back into the water body as lifeless sediment. These high destruction rates can overtake recovery rates, resulting in extensive depletion of the affected species. In this way, entire marine communities can lose their capacity to sustain themselves.

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In addition, should a reactor abruptly shut down, water temperatures around the plant will drop causing cold-stunning, an event fatal to fish acclimated to the warmer water. Occasionally, reactor operators deliberately raise the temperature of the water inside the coolant system to kill mollusks encrusting the pipes. Fish that cannot escape are scalded and discharged into the local marine environment. This increases the clouding of the water around the discharge structure already caused by the volume of hot water gushing from the reactor, further impeding the growth of essential marine plants such as kelp.

The hot discharge water damages and destroys fish and other marine life and dramatically alters the immediate marine environment. Warmer waters have been found to cause a fatal disease, known as “withering syndrome,” in black and red abalone, which have been virtually eliminated around Diablo Canyon in California with little chance of recovery, even if the water temperatures return to normal. The warmer temperatures drive away indigenous species of fish and attract others whose populations flourish, further stressing the displaced species and threatening their survival. Kelp, unable to photosynthesize efficiently due to the shadowing effect of discharge sediment, also is weakened by higher water temperatures. In the immediate discharge areas, the ocean floor is scoured clean of sediment by the force of the thermal discharge, resulting in bare rock and creating a virtual marine desert. Areas farther from the discharge become coated in heavy, life-stifling sediment. Unusually altered water temperatures have been shown to interfere with the normal behavior patterns of some species of fish, including striped bass, consequently disrupting the completion of necessary life-cycle activities.

The utility operating the reactor typically conducts the reporting and analysis of fish kills. This method of self-reporting inevitably results in gross underestimates of fish kills at nuclear reactors. In one example of cold-stunning when the Oyster Creek station in New Jersey shut down, the utility officially reported several hundred fish mortalities, but sightings by local fishermen recorded at least 4,000 dead striped bass. In fact, the utility had counted only fish found within the reactor’s property perimeter and not those beyond plant boundaries. The full magnitude of the damage to fish populations from nuclear power operations is likely far greater than suggested by unreliable estimates from utilities.

Species-Specific Harmful Effects: Marine Mammals and Other Marine Wildlife

The nuclear industry values economic profits over reducing harm to wildlife and the humane treatment of marine animals. Nonendangered species such as seals and sea lions are drowned at nuclear plants, often with the tacit approval of NMFS, the agency that grants permits for take limits it judges will not impair the species' survival. However, the agency's decision-making process does not factor in the slow, inhumane drowning of marine mammals through a reactor intake tunnel. It is left to environmental watchdog groups to draw attention to the plight of these animals. This is what happened at the Seabrook reactor in New Hampshire where the drowning of seals ceased after activists pressured the utility into installing preventive bars at the intake tunnel.



An endangered manatee mother swims with her calf. In Florida, manatees have been sucked through reactor intake pipes. One was found dead at Turkey Point but the necropsy was incon-

Endangered manatees and American crocodiles have been captured and killed at atomic reactors. Manatees have also fallen prey to habituation to the artificially warmed waters, a problem that has resulted in cold-stunning of the animals when the plants reduce power or shut down. In Florida, manatees were sucked through the St. Lucie intake pipe, both before and after repairs to the opening through which they entered. The experience of a human diver who survived entrainment through the St. Lucie pipe in 1989 tells us that the victim must endure turbulence, darkness, and severe tearing by large, sharp barnacles encrusted on the pipe's interior.

Although the Turkey Point nuclear station in Florida has positioned itself as a "sanctuary" for American crocodiles, the animals have also died there, at least one apparently from impingement against the suction of the cooling canal skimmer pumps. The crocodiles, attracted by the artificially warmed discharge water, cluster around the plant, vulnerable to injury from plant operations. Turkey Point has also reported a manatee mortality.

Various breeds of diving ducks have drowned at nuclear plants, sucked through the intake structures into the circulating water systems. Almost no attention has been paid to these incidents, even though at least one resulted in the death of 103 greater or lesser scaup, a bird whose numbers have declined at an alarming rate in recent years. The elimination of 103 members of a single population of scaup, if repeated, could have serious consequences. Scaup are attracted by zebra mussels that reportedly flourish on water intake structures, but no preventive methods are known to avoid fatalities among these feeding birds.

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Even when reluctantly complying with protective requirements, some plants do further damage to the environment. Operators of the Salem reactors in New Jersey were obligated to restore wetlands in the area. But in doing so, they broke a dike and cut a channel to create a flat marshland that has proven deadly to the already diminishing horseshoe crab population. The dredging effort that broke the dike was particularly destructive, as the utility chose not to halt the operation during the crabs' breeding season. Repeated herbicidal sprayings have also harmed the estuarine environment the utility is charged with protecting.



Articles such as this in *Nuclear Industry* magazine, make misleading claims about the benefits to wildlife of nuclear power operation without revealing its true destruction.

False Advertising

The nuclear industry has spent tens of millions of dollars over the years, attempting to portray itself as environmentally friendly and beneficial to wildlife. Some of its advertising and promotional efforts have featured the same animals killed or captured at nuclear reactors such as seals, sea turtles, and American crocodiles. Industry advertising and promotional materials have claimed that “sea creatures and nuclear plants get along well,” that nuclear power “helps protect the environment,” and even that nuclear reactors cause “no harm” to sea turtles. Utilities use their web sites to trumpet token gestures toward conservation such as sea turtle nest counts, without telling readers about their own part in destroying these same species as they attempt to nest on land now occupied by atomic reactors.

When nuclear power advertisements were challenged in 1998 by consumer, environmental, business, and public policy groups, the industry at first defied recommendations from the National Advertising Division of the Council of Better Business Bureaus (NAD) to cease its deceptive practices and amend its advertising messages. However, the NAD referred the case to the Federal Trade Commission, which urged the industry to “take to heart the evaluation of its advertising that has been rendered by its peers” and agreed that the industry had “failed to substantiate

its general environmental benefit claim.” Only then did the industry buckle to pressure and its advertisements no longer feature sea turtle hatchlings or basking sea lions. Again, without the intervention of watchdog organizations, the nuclear power industry will continue to mislead the public about its effect on endangered and other marine wildlife.

Conclusions and Recommendations

Nuclear power plants use the once-through cooling system to save money. When presented with the opportunity to install cooling towers at the time of construction, many reactor owners declined, citing financial burdens. By this choice, the utilities passed the cost on as environmental damage.

The nuclear industry is allowed to self-monitor and self-regulate to an unacceptable degree.

Today, with nuclear power in steep economic decline, the industry once again argues that it cannot afford to retrofit with cooling towers to curb harmful impacts on the marine environment.

The nuclear industry is allowed to self-monitor and self-regulate to an unacceptable degree. Subject to lenient and often accommodating regulatory oversight, reactor operators will deliberately leave out essential information about damage to the marine ecosystem when reporting to state and federal authorities. In the case of PG&E and its Diablo Canyon site, the utility remained silent about the true extent of destruction to marine life and habitat around the reactor. In other instances, mitigation promises made at the time of licensing were quickly broken. The industry flaunts the threat of litigation to force authorities into accepting minimal penalties for repair to the environment damaged or fundamentally altered by the operation of atomic reactors.

Regulatory authorities must rely on the honesty of nuclear utilities to report accurately the captures and deaths of marine wildlife at nuclear reactors. Such reporting is erratic, inconsistent, and some-

times absent altogether. Utilities often fail to report at all to NRC, preferring to provide information about the deaths of marine animals to NMFS or state departments of environmental protection. This circumvents the tenets of the Endangered Species Act and the Marine Mammal Protection Act and effectively shields the industry from public scrutiny. This is compounded by NRC's own inconsistencies. At times, NRC posts information about wildlife kills and captures at reactors on its Daily Events Reports (DER) that appear on its website. At others, it records this information only in the archives of its Public Document Room. The public must therefore inquire 'on spec' to ascertain whether or not captures have taken place and not assume that the DER postings provide a full accounting. These inconsistencies, from the utilities to the federal authorities, make it extremely difficult for the public to know the true extent of the destruction of marine life at atomic reactors.

The nuclear industry flaunts sea turtle nest protection efforts at the same time its reactors capture egg-bearing females attempting to nest.

The NRC, the federal authority charged with enforcing compliance with take limits, mitigation actions, and other requirements, acts more as a lapdog than a watchdog. In fact, NRC often persuades permitting agencies such as NMFS to buckle to the industry's professed economic needs by convincing the agency "not to fall on their sword" over requirements such as sea turtle entrainment studies. Under NRC's watch, the marine environment, not the nuclear industry, has paid the price for electricity generated by once-through nuclear power reactors. NRC is even willing to come up with preplanned scenarios to help NMFS "save face" when confronted with utility resistance to needed mitigation measures. Although NMFS occasionally presents nuclear utilities with convincing arguments for protective measures, it rarely stands by its original opinions once NRC-supported industry opposition has been considered.

The nuclear industry makes only token gestures toward protective actions and balks at any serious repair of the environmental destruction it has caused. Instead, the industry portrays atomic reactors as environmentally friendly wildlife sanctuaries, a myth as deceptive as the industry's earlier promise of electricity "too cheap to meter." It flaunts sea turtle nest protection efforts at the same time its reactors capture egg-bearing females attempting to nest. It is left mainly to environmental watchdogs and animal protection organizations to advocate for protective measures and publicly to expose the industry's destruction of marine wildlife.

Endangered species such as sea turtles, manatees, American crocodiles, and least terns, along with a wide variety of fish, other marine mammals, sea birds, and smaller, essential marine organisms, are species whose numbers are further diminished by the operation of nuclear power. The survival and safety of these animals is of negligible interest to an industry that prizes profit above all and shifts blame to other causes when confronted with the rising deaths and injuries of these creatures at its reactors.

Noted scientists and oceanic experts agree that the health of the world's oceans is in jeopardy. Yet, the nuclear industry is willing to destroy significant areas of marine habitat through daily operation of its once-through coolant reactors. When presented with the opportunity to repair some of the damage, the industry instead fights back with threats of costly and protracted legal challenges. Though willing to spend millions of dollars and countless years fighting lawsuits, the industry is not willing to finance protection of the endangered species it kills or restoration of the marine environment it destroys. The nuclear industry displays a callous disregard for the importance of the oceans as a life source and marker for environmental and human health.

The agencies empowered both to regulate the industry and to protect the public, wildlife, and environment from industry wrongdoing are lax at best, even negligent and collusive. Though entrusted to enforce laws largely designed for the well-being of humans, wildlife and habitat, agencies

such as NRC and NMFS are in fact more inclined to favor industry needs at the expense of human and environmental health.

Given the nuclear industry's refusal to install less damaging technology or to implement even the smallest of protective measures at its once-through reactors, an essential option exists that can prevent further and potentially catastrophic damage to the oceans and the life that dwells there. The *precautionary principle*—whereby activities that harm the environment are halted before the damage is irreversible, and the burden of proof is placed upon the polluter, not the public—is not only a timely, but an essential, approach. Consequently, we recommend that the use of once-through cooling technology be halted before more animals are harmed and further, irreversible damage is done to essential marine ecosystems. Only in this way can the marine environment be protected from one of its most aggressive predators. Additionally, nuclear utilities should adhere to the same standards of law as other industries and such laws that do apply must be implemented consistently.

Clarification of Report Criteria

This report is an examination of the effects on marine life and habitat of the condenser cooling systems used to operate U.S. coastal nuclear power reactors. The report does not presume to portray the full extent of marine destruction caused by nuclear utilities. Nor does it attempt to examine the many significant radiological and toxicological issues affecting water and environmental quality directly associated with the ongoing operation of nuclear power stations. These effects are omitted from this report to provide a focus on the nonradiological issues, not because these impacts are insignificant. Nor does this report cover the effects of nuclear power operation on terrestrial wildlife and endangered nonmarine species.

Reactors examined are a selection of primary users of the once-through cooling system. The findings here represent examples of reactors chosen because of their known or suspected effects on marine life. The report is not meant to provide the definitive analysis of once-through systems at every U.S. nuclear plant. This does not mean that reactors not specifically named in this report do not cause similar effects. Indeed, all reactors using the once-through cooling system routinely destroy millions of aquatic organisms, large and microscopic. The species affected, the quantity and type of destruction, and other specifics may differ, but the harmful consequences are no less critical. Much of the material in this report comes from Freedom of Information Act requests and has never before been released to the public.

The authors present this as a preliminary analysis of findings to date. This report does not constitute a complete study, as events continue to unfold and circumstances to change at nuclear plants around the country. However, it is apparent that the lack of investigation, analysis, and enforcement by NRC and other responsible federal and state agencies has left a void in the patchwork of regulated protection of marine species and their habitat. Fair and equitable regulation of the harmful impacts of the coolant intake and discharge system must now be implemented.