TREADING **WATER**

How States Can Minimize the Impact of Power Plants on Aquatic Life

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) has proposed, and is expected to soon finalize, a new water pollution regulation for cooling water intake structures at existing power plants. The rule will require state environmental agencies to revisit 600 old power plants and determine whether they should continue to use outdated industrial cooling systems that withdraw massive volumes of water from waterways across the nation and kill billions of fish every year. EPA's rule fails to set minimum standards for protecting aquatic ecosystems and fails to give states clear and effective guidance on how to regulate cooling water intake structures. This report examines the level of preparedness of state agencies to make regulatory determinations regarding the use of these highly destructive cooling systems. The report identifies best practices from around the country in order to help state officials compare their industrial cooling water policies against those of other states. At the same time, the report is designed to give concerned citizens and environmental organizations the facts they need to advocate for protection of America's lakes, rivers, oceans and estuaries.

The key findings of this study are:

- The states that achieve the most environmentally protective permitting outcomes generally begin by identifying the best technology — closed-cycle cooling — and then ask whether this technology is technically and economically feasible at each plant. Closed-cycle cooling would save nearly 2 billion fish and 500 billion eggs and larvae every year, protect dozens of endangered species, help restore thousands of ecosystems, and increase the resilience of waterbodies and of power plants to periods of extremely hot weather caused by short-term heat waves or long-term climate change.
- In contrast, other states do nothing to reduce impingement and entrainment at power plants unless they decide that there is definitive proof that the millions (or billions) of aquatic organisms that are killed represent a "significant" impact on the population of a certain species, or on the ecosystem as a whole. These states not only achieve inferior environmental outcomes, but they and their permittees also may invest more resources in the permitting process because the high biological threshold of proof imposes heavy analytic demands.
- In recent years, more and more old plants that were originally built with a once-through system have converted to closed-cycle cooling. Closed-cycle systems so greatly outperform every other technology that EPA studies the possibility of a retrofit at every old power plant that it permits directly.
- Many state environmental agencies approved once-through cooling systems at dozens of power plants in the 1970s and 80s and have never revisited those decisions. They now face a backlog of plants that will need to be re-examined under EPA's new rule, but these regulatory agencies suffer from a lack of institutional knowledge and experience, due to the decades that have passed since they last tried to address this issue.
- In states that use cost-benefit analysis at individual plants, the analyses are universally inadequate and incomplete. For example, many states accept cost-benefit analyses prepared by the power plant owner in which all non-commercial species of fish, often called "forage fish," are considered worthless.
- Some states miss the links between ensuring a reliable supply of energy and environmental protection. Closed-cycle cooling increases the reliability of the power grid during droughts and heat waves. State regulators should consider the energy security benefits of requiring an old power plant to install closed-cycle cooling. But because some states analyze "energy" and "the environment" separately, they do not consider the full benefits of closed-cycle cooling in their analysis.
- Many power plants voluntarily use reclaimed water from municipal wastewater treatment plants to reduce or eliminate their withdrawal of cooling water from lakes and rivers. Although all regulators welcome this kind of water reuse, only California has adopted a formal policy encouraging industry to reuse reclaimed water. Other states may be able to increase water reuse and reduce fish kills by following California's example.
- Once-through cooling is not just bad for the environment. Once-through cooling is bad for power plants — and for electricity users too — because it reduces the ability of power plants to cope with drought, heat waves, and climate change. State regulators include these issues in their analysis.

INTRODUCTION

Old power plants kill fish by sucking water out of rivers, lakes, harbors and estuaries. The power industry uses more water than any other sector of the U.S. economy. Nearly all of this water is used for "once-through cooling," an outdated process that uses enormous volumes of water and discharges it back into the environment at an alarmingly elevated temperature. In the process those cooling systems kill much of the aquatic life near the intake pipe and the heated discharge water alters surrounding ecosystems, compounding the damage. A single plant may withdraw hundreds of millions or billions of gallons each and every day, obliterating millions of adult fish and billions of fish eggs and larvae in a single year. And multiple plants line some of America's most iconic and valuable ecosystems, such as the Hudson, Delaware and Mississippi Rivers, the Chesapeake Bay and all of the Great Lakes.

Nationally, the once-through cooling systems at older power plants kill more than 2 billion fish, crabs and shrimp every year, and more than 528 billion eggs and larvae that serve as the basis of the aquatic food chain. EPA estimates that the fish and invertebrates killed by power plant intakes include as many as 215 species that are federally listed as threatened or endangered. The toll includes Shortnose and Atlantic Sturgeons, unique populations of Chinook Salmon and Steelhead Trout, and at least three species of sea turtles: the Green Turtle, Loggerhead Turtle, and Kemp's Ridley Turtle. These animals are not only unique and irreplaceable, they also play critical ecological roles and serve as barometers for the health of their respective habitats.

In the 1972 Clean Water Act amendments, Congress ordered EPA to set rules that would require power plants to use the "best technology available" in order to minimize the adverse environmental impact of their cooling systems. But more than forty years later, EPA still has failed to set rules for the cooling systems at more than 600 old power plants. Instead of developing clear federal rules, for four decades federal and state regulators have made decisions about the cooling systems at old plants on a case-by-case basis, in a process referred to as a "best technology available" or BTA determination. Unfortunately, the result has been 40 years of bureaucratic paralysis and continued decimation of U.S. fisheries. Hundreds of the power plants that Congress had in mind in 1972—plants that are now 40, 50, or 60 years old—still use antiquated, once-through cooling systems that kill billions of fish every year.

States have been in charge of regulating cooling systems at old power plants for forty years. In that time, most have done little or nothing to protect fish and aquatic ecosystems from cooling water intakes.

There is some positive news in this story. Since 1972, the power industry has largely stopped building once-through cooling systems at *new* power plants. For decades, almost every new power plant in America has been built with a "closed-cycle" cooling system. Instead of taking in thousands of gallons of fresh water every second of every day, closed-cycle systems recycle the same cooling water many times. Closed-cycle cooling reduces water use and fish kills by more than 95 percent. No other technology or operation measures approach this level of performance and environmental protection. Therefore, in 2001, EPA made closed-cycle cooling mandatory for all new power plants (with some very limited exceptions).

Since 2001, however, progress has stalled. Hundreds of existing power plants continue to operate antiquated cooling systems. And instead of setting protective national standards for these old power plants, EPA now plans to continue the status quo, leaving the responsibility for making BTA determinations to severely overburdened state regulators.[1] Under EPA's proposal, state environmental agencies will spend the coming years making more than 600 BTA determinations, one power plant at a time, to decide whether old, dirty plants must finally make the same environmentally protective investment in closed-cycle cooling that their newer competitors were forced to make years (or decades) ago. EPA's decision puts a heavy load on state agencies that have undergone severe budget cuts in recent years.

EPA is also putting a heavy burden on citizen groups and community organizations. Without a strong federal rule to protect fish and aquatic ecosystems, local communities will routinely need to get mobilized, informed and engaged with state environmental agencies. To ensure that old plants are finally brought up to

modern industrial standards, residents and community groups will need to make their voices heard every time that the state plans to renew a water pollution permit at an outdated power plant—and will need to do so against the powerful interests that are resistant to change.

On the positive side, EPA's rule acts like a reset button for state environmental agencies: it forces them to take a fresh look at the cooling systems of old power plants. In some cases, a fresh look is long overdue; some states have not re-examined the cooling water systems of their oldest plants in decades.

But EPA is giving state environmental agencies excessive latitude and discretion in reaching final BTA determinations. As drafted, the new rule will only protect fish and ecosystems if states use this reset as a chance to rethink their policies on industrial cooling water and decide to end the destructive use of once-through cooling systems. But the states have been in charge of regulating cooling systems at old power plants for forty years. In that time, most have done little or nothing to protect fish and aquatic ecosystems from cooling water intakes.

Thus, EPA is missing its best opportunity to establish a strong, protective baseline for America's rivers, lakes, and harbors. If EPA set a presumption that closed-cycle cooling is the best technology available at every site and put the burden on power plants to justify a downgrade to a less-protective technology at their site, the rules around cooling water intakes would be clearer, more easily implemented, and more environmentally protective. But by not starting with a high level of protection, EPA is making it far easier for states to perpetuate an unacceptable status quo.

The cost of continued inaction by state governments and EPA is staggering. As noted, America's hundreds of old power plants destroy more than 2 billion fish and 528 billion eggs and larvae every year, including members of almost 215 endangered or threatened aquatic species, from sea turtles to shortnose sturgeon. And data from a recent economic study conducted by EPA show that the social and environmental benefits of switching to closed-cycle cooling at all of these old plants exceeds the cost.

In recent years, a number of states have noted the accumulating evidence and made a break with the past. These states have started requiring old power plants to stop killing millions of fish and to install closed-cycle cooling systems. If more states adopt the permitting practices of these leaders, dozens of endangered species, thousands of ecosystems around the United States, and billions of fish will be protected.

Given the power industry's current heavy reliance on water resources, water-friendlier electricity generation is a key part of a more sustainable energy future. With changing precipitation patterns brought on by climate change, collaboration among planners, managers, policymakers and regulators is a necessity if we are to ensure adequate water resources not only for energy production, but also for food production, municipal, commercial and industrial uses.

This report is based on a review of permitting practices, water pollution permits and policy documents obtained through freedom of information requests, as well as on discussions with staff of more than a dozen state and federal environmental agencies and discussions with environmental organizations that have participated in BTA determinations in several states.

The states covered in this report are broadly representative of the wide spectrum of permitting practices across the United States. At one end, California and Delaware have made it their official policy to push every power plant within their borders to finally move to closed-cycle cooling technology. At the other end, Illinois has not re-examined the cooling systems at many power plants for more than 30 years. And while states like Louisiana, Texas and Ohio re-analyze cooling systems periodically, they have signaled through public comments and permitting practices that they believe older power plants should rarely, if ever, be required to upgrade to closed-cycle systems.

Part One of this report summarizes the case for stronger environmental control of power plant cooling systems. Part Two outlines criteria and differences in practice that distinguish the best state permitting practices from the worst. Finally, Part Three provides evaluations of the BTA determination processes of eleven permitting agencies covering twelve states on the East Coast, West Coast, Gulf of Mexico and Great Lakes.

PART ONE:
COOLING WATER INTAKES WHY THEY MATTER, WHAT CAN BE DONE

THE PROBLEM OF COOLING WATER

The power industry uses more water than any other sector of the economy, withdrawing more than 200 billion gallons of water each day from our mighty rivers and treasured waterways and harbors. This accounts for 93 percent of the country's total saltwater use, 41 percent of total freshwater use and 49 percent of all water use. That's more water than all irrigation and public water supplies combined.[2]

Nearly all this water is used for "once-through cooling," an antiquated technique in which power plants take in enormous volumes of water to cool their systems and then discharge it at an elevated temperature, causing severe ecosystem destruction. A power plant with once-through cooling draws hundreds of millions, in some cases billions, of gallons of water each day from the closest lake, river or ocean and indiscriminately sucks in whatever aquatic life is near the intake pipe. Fish and other aquatic life are smashed and mutilated ("impinged") against crude screens or are sucked ("entrained") into the cooling system. Impingement and entrainment at a single power plant can obliterate billions of fish eggs and larvae and millions of adult fish each year, and the heated water once-through cooling systems discharge also alters surrounding ecosystems, compounding the damage. Once-through cooling systems affect the full spectrum of wildlife in the aquatic ecosystem at all life stages — eggs, larvae, juveniles and adults — from tiny photosynthetic organisms to fish, shrimp, crabs, birds and marine mammals.

Many of the species of fish and shellfish and other organisms killed by power plants are endangered or threatened. EPA has identified 88 threatened or endangered species at risk from cooling water intakes and believes that more than 130,000 threatened or endangered animals are killed by cooling water intakes every year.[3] At just one power plant in Florida, over a thirteen year period, 144 endangered sea turtles were found dead and trapped in the plant's cooling water intake canals.[4] Marine mammals, such as manatees, are also adversely affected. Once-through cooling systems also harm endangered species indirectly by altering food webs and critical habitats.[5]

Killing billions of fish and elevating the temperatures of receiving waters has a hugely destabilizing impact on surrounding ecosystems. EPA has found that the loss of large numbers of aquatic wildlife may affect the overall health of ecosystems.[6] And once-through cooling also reduces species' ability to survive other unfavorable environmental conditions, such as drought and climate change.[7]

The death toll is staggeringly high. A single once-through cooling system can impinge a million adult fish in a few weeks during the breeding season, and can entrain billions of smaller fish and shellfish in a year. For example:

- Salem Nuclear Generating Station, New Jersey — 1.12 million weakfish and 842 million bay anchovy killed annually; four times more than are caught by commercial fishermen.[8]
- Brunswick Nuclear Plant, North Carolina — 3 to 4 billion individual fish and shellfish entrained at early life stages annually. Studies predict an associated 15–35 percent reduction in local fish and shellfish populations, which may be altered beyond recovery.[9]
- Donald C. Cook Nuclear Plant, Michigan — one million fish killed during a three-week study.[10]
- Indian Point (Nuclear) Energy Center, GenOn Bowline Point Station (gas/oil), Roseton Generating Station (gas/oil), Mirant Lovett Generating Station (coal) and Danskammer Generating Station (coal),[11] New York — cumulatively, the five power plants on New York's Hudson River have killed as many as 79 percent of all the fish born in a single species in a single year.[12]
- San Onofre Nuclear Generating Station, California — 121 tons of fish entrained in a normal (non-El Niño) year, causing a 34–70 percent decline in Pacific Ocean fish populations within 3 kilometers. On June 7, 2013, Southern California Edison announced it would shut down the San Onofre nuclear power plant.[13]
- Bayshore Plant, Ohio — In 2008, the plant owner estimated that it killed more than 60 million adult fish and more than 2.5 billion fish eggs and larvae in a year.[14] A University of Toledo study conducted around the same time put the number of fish eggs and larvae killed annually at more than 12 billion.[15]
- Oak Creek Power Plant, Wisconsin — more than 2 million fish (57 tons of fish) killed in a year, plus 15 million eggs and larvae.[16]

Even making some very conservative assumptions, EPA estimates that industrial cooling water withdrawals kill at least 2.2 billion "age one-equivalent"[17] fish, crabs and shrimp every year, and at least 528 billion of the fish eggs and larvae that serve as the basis of the aquatic food chain. While these figures include manufacturing facilities, power plants cause approximately 90 percent of the damage.

Finally, once-through cooling is not just bad for the environment. Once-through cooling is bad for power plants—and for electricity users too—because it reduces the ability of power plants to cope with drought, heat waves, and climate change. In 2011 and 2012, power plants in the Southeast, Texas and parts of the Midwest and Southwest weathered lengthy drought conditions. In these areas, many of the older plants that still use once-through cooling turned to emergency intakes or held back much-needed water in reservoirs instead of releasing it to downstream farmland, drinking water providers and other water users. And in August 2012, the Millstone nuclear plant in Connecticut had to shut down an electricity generating unit that provides nearly a quarter of the state's power because the waters of Long Island Sound were too hot and the once-through cooling system could not adequately control the plant's operating temperature.[18] Last summer, a global team of researchers writing in the scientific journal Nature Climate Change concluded that, by the 2040s, U.S. power plants with once-through cooling systems will need to adapt their cooling systems or risk decreases of average summer usable capacity of 12–16 percent.[19]

SUPERIORITY OF CLOSED-CYCLE COOLING

The best alternative to once-through cooling is called "closed-cycle cooling." As the name suggests, in a closed-cycle cooling system, water is recycled many times in a closed loop: cold water circulates through a power plant to remove excess heat, then releases that heat in a cooling tower. Once it cools down, the water is sent back to the plant to draw off even more heat. When plants use closed-cycle cooling instead of once-through cooling, only a small quantity of water (approximately 2.5 percent) must be added periodically to make up for evaporation. As a result, EPA concluded "that freshwater cooling towers and saltwater cooling towers reduce impingement mortality and entrainment by 97.5 percent and 94.9 percent, respectively."[20] And because high temperature water is cooled and reused, closed-cycle cooling also eliminates the environmentally damaging thermal discharges associated with once-through cooling.

In recent years, more and more old plants that were originally built with a once-through system have converted to closed-cycle cooling. Closed-cycle systems so greatly outperform every other technology that EPA studies the possibility of a retrofit at every old power plant that it permits directly.

EPA has assessed a wide range of different technologies for controlling impingement and entrainment, from various kinds of screens and structural barriers to offshore intake structures; intake velocity reductions; and nets.[21] After comparing all of these possibilities, EPA found that none offers the environmental benefits of closed-cycle cooling.[22] For example, one of the most popular (and least costly) technologies in use at old power plants are screens. Power plant owners frequently claim that these screens are the best technology available. But screens only reduce impingement by—at best—around 30 percent, as compared to a 98 percent reduction with closed-cycle cooling.[23] And screens do nothing whatsoever to reduce entrainment or thermal pollution.

By the 1980s, closed-cycle cooling was already standard industry practice for new power plants. In 2001, EPA made it official; it determined that closed-cycle cooling is the best technology available for all new power plants.[24] Today, closed-cycle cooling is mandatory (with very limited exceptions) for all new power plants. Almost no plants have been built using once-through cooling in 30 years. And in recent years, more and more old plants that were originally built with a once-through system have converted to closed-cycle cooling. Closed-cycle systems so greatly outperform every other technology that EPA studies the possibility of a retrofit at every old power plant that it permits directly.

THE HIGH COST OF INACTION

Although closed-cycle systems are far more effective at saving fish and protecting waterbodies, about 600 existing power plants still operate once-through cooling systems that are 40, 50, or even 60 years old. Over time, they kill hundreds of billions of fish and other organisms, including members of around 90 endangered or threatened species.

The environmental benefits of finally converting all of these plants to closed-cycle cooling would be enormous. Closed-cycle cooling would save nearly 2 billion fish and 500 billion eggs and larvae every year, protect dozens of endangered species, help restore thousands of ecosystems, and increase the resilience of waterbodies and of power plants to periods of extremely hot weather caused by short-term heat waves or long-term climate change.

The environmental and economic costs of continuing to use once-through cooling, on the other hand, are simply too high. In the Delaware estuary, the Salem nuclear power plant alone destroys more commercially valuable fish than are caught by the entire fishing fleet. From the Hudson River to the Florida Keys, old power plants push threatened and endangered species closer to the brink of extinction.

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The costs of converting old power plants to closed-cycle cooling are minimal from both a macroeconomic and a microeconomic perspective—even under the most extreme scenario, the cost is less than 0.033 percent (1/30th of one percent) of national GDP.[25] At the company level, EPA's electric system modeling analyses demonstrate that very few, if any, power plants would retire rather than come into compliance—at the very most, 1.5 percent of existing power capacity.[26] And this is clearly an overestimate because EPA assumed that power plants would absorb 100% of the costs.

The extent to which older power plants can absorb closed-cycle cooling costs is illustrated in a report by the economist Robert McCullough, entitled the Economics of Closed-Cycle Cooling in New York,[27] which shows that for the vast majority of the time, the market clearing price of electricity in New York State (the price that all plants are paid for electricity regardless of their costs or the price they bid) is set by newer plants with closed-cycle cooling. Thus, New Yorkers (and residents of other deregulated states) already pay power prices that cover the cost of building and operating closed-cycle cooling systems—the existing plants that still use old, once-through cooling are pocketing the difference between their lower costs and the market clearing price as profit.

Now, a new national study from EPA confirms that the benefits of switching to closed-cycle cooling exceeds the costs. EPA estimates that replacing outdated cooling systems requires an investment of between $4.5 and $4.9 billion per year—an investment that will create thousands of construction jobs.[28] EPA also conducted a national economic survey to estimate the cash value that Americans put on the vital natural resources that are damaged by once-through cooling systems. The results indicate that the environmental benefits from modernized cooling systems will be at least $5–7 billion annually, even under a series of highly conservative and unrealistic assumptions.[29] Frank Ackerman, a noted environmental economist, concluded that the benefits are more likely in the range of $13 to $18 billion.[30] By any measure, switching America's old and outdated power plants over to closed-cycle cooling will create thousands of jobs at a net savings to Americans.

EPA SHOULD NOT LEAVE THIS JOB TO THE STATES

In the early 1970s, a number of well-publicized, massive fish kills occurred at intake structures around the country. In response to these fish kills and other threats to our waterways, Congress voted overwhelmingly to pass the Clean Water Act of 1972 into law. While it focuses mostly on the discharge of pollution, the law also specifically regulates cooling water intake structures. In the Clean Water Act, Congress directed EPA to ensure that power plants and other industrial facilities used the "best technology available" (BTA) to minimize the environmental harms of cooling water withdrawals.

Instead of following the orders of Congress, for decades EPA has left regulation of older power plants to state environmental agencies. Many state agencies clearly lack the resources and political will to regulate power plants—across the United States, almost half of all water intake and discharge permits for old coal-fired power plants are expired because state agencies either will not enforce our clean water protections or are too overburdened to comply. When making a "BTA determination"—determining the "best technology

available" for cooling water withdrawals — many state agencies simply accept the use of existing intakes.

In 2004, EPA proposed national cooling water intake rules for older power plants. But these were so weak and deficient that a federal court struck down much of what EPA had written, causing the agency to suspend the rules altogether.[31]

EPA finally proposed new regulations for older power plants in 2011, but it again set a very low standard for reducing impingement and, this time, did not set a standard for reducing entrainment at all. EPA's new regulations fail to set a clear national policy that phases out once-through cooling systems or protects aquatic resources. Instead, over the coming years, EPA expects overstretched state agencies to revisit each of the nation's 600 existing once-through cooling systems at power plants, as well as another 600 at facilities in other industries, and make new BTA determinations for all of them on a case-by-case basis.

Those BTA determinations will be heavily influenced by power companies. EPA proposes that the power companies that own old power plants should submit complex biological, engineering and economic studies to state agencies. The studies will include the power company's evaluation of whether a closed-cycle system is technically feasible and cost-effective at their plant. Although the studies are subject to peer review, the peer reviewers will be hired and paid by the power company.

Under EPA's rule, the states are expected to closely review all of the industry-prepared studies for each plant on a case-by-case basis and catch any data errors or analytical gaps. Based on these studies, EPA also recommends that states analyze the benefits and costs to society of different cooling water intake controls — including the costs and benefits of moving to closed-cycle cooling — before making a final BTA determination.

If EPA's rule is finalized in its proposed form, the federal agency will have missed a chance to end the staggering fish kills at older power plants and advance the level of technology deployed by the power sector. Instead, EPA will just place heavier burdens on state regulators that already cannot keep up with their water pollution permitting obligations, thereby making the state BTA process more important and less effective than ever.

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PART TWO: BEST AND WORST PRACTICES

EPA is offloading a considerable burden onto state regulators. Under EPA's plan, the states must oversee and review complex biological, economic and engineering analyses performed by power companies. Based on those studies, states must reach case-specific decisions about the ecological impact of each cooling water intake, the technology options that are feasible for the intake and whether the costs and benefits to society justify a shift to closed-cycle cooling. Are state environmental agencies ready to shoulder the load?

Overall, the answer is no. Cooling water intakes at old power plants have been regulated by the states for the last forty years, for the most part to little effect. While EPA's proposed rule will force state environmental regulators to reconsider how they regulate cooling water intakes at old power plants, the decision making process is complex, open-ended and heavily influenced by power plant owners and operators that reap enormous economic gains by maintaining the status quo. It is unrealistic to expect a sudden improvement in most states under EPA's new rule.

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It would be better if EPA set a clear, national rule that favors closed-cycle cooling and did not leave the states with the burden of making site-specific decisions. As discussed, EPA has the evidence, institutional knowledge and resources to justify such a rule. In contrast, state environmental agencies are already overburdened and under-resourced; this new rule leaves them even more work to do, and more reliant than ever on research provided by regulated companies rather than independent, objective analysis.

Case-by-case determinations are lengthy, expensive, and time consuming. EPA's regional office for New England (known as Region 1), which issues NPDES permits in Massachusetts and New Hampshire, writes thorough and reasoned BTA determinations that EPA clearly intends for state regulators to use as a model. But the BTA determinations in these permits are themselves voluminous, and often rely on hundreds of pages of supporting data and analysis. Many states, including New York, New Jersey, Texas, Louisiana, Michigan, Wisconsin, Minnesota, and Kansas, have complained to EPA of the extreme burdens of making BTA determinations on a case-by-case, site-specific basis,[32] sometimes saying flat-out that they cannot do it.

But the outlook is not entirely negative. Some states are well positioned to set environmentally protective, evidence-based standards for cooling water systems that will end the use of once-through cooling. In the last decade, states including California, Delaware and New York have adopted policies that favor closed-cycle cooling. These states are pushing old power plants to catch up with their newer peers by replacing old, destructive intake systems. New Jersey, while not as consistent as these other states, has issued one draft permit for a large nuclear power plant that required the use of closed-cycle cooling. And in recent years, EPA has required three old power plants in New England to install closed-cycle cooling in order to reduce thermal pollution and stop killing fish. A trend towards better permitting of cooling water intakes is emerging.

This section outlines areas in which the authors believe it is possible to distinguish the best state permitting practices from the worst. The states that have adopted best practices are more likely to make environmentally protective BTA determinations in response to EPA's rule. State regulators can use these best practices to benchmark themselves relative to their peers. On the other hand, the absence of best practices should be considered a red flag for citizens and community groups. States that have not adopted best practices likely will continue to let old power plants kill fish and degrade aquatic habitat. Citizens and community groups in these states will need to engage in the water pollution permitting process more aggressively to obtain strong environmental protections and end fish kills in local waterbodies.

1. TECHNOLOGY EVALUATION PROCESS: SEEK THE BEST TECHNOLOGY, AS REQUIRED BY LAW.

The single most important factor in distinguishing between the best and worst performing states is whether they proactively try to reduce impingement and entrainment to the greatest extent possible or,

The EPA long ago decided (and the courts agreed) that the "adverse environmental impacts" that the Clean Water Act requires it to address are the killing of millions of fish and eggs.

instead, only react when fish populations have crashed and the crash can be traced readily to a power plant.

The states that issue the most environmentally protective permits are doing what the Clean Water Act requires. They start by identifying the best performing technology — closed-cycle cooling — and then try to determine whether this technology is technically and economically feasible at each plant. In these states, if closed-cycle cooling is feasible, it is required. If there is a compelling reason that a plant cannot retrofit its cooling system — for example, it lacks the physical space required — only then do state regulators consider alternative technologies.

This kind of technology-based approach is what the law requires. It offers a clear decision-making process and takes advantage of the evidence in favor of closed-cycle cooling that has been assembled over the past few decades. As noted above, that evidence includes: the fact that closed-cycle cooling has been a standard practice in the power sector for more than four decades; EPA has found closed-cycle systems to be far more effective at saving fish and reducing thermal pollution than screens, deterrent barriers, or other devices tacked on to a once-through cooling system; and economic analyses show that the value to society of the fish and other organisms killed by power plants exceed the costs of closed-cycle cooling.

In contrast, other states do nothing to reduce impingement and entrainment at power plants unless they first conclude that the millions (or billions) of aquatic organisms killed at a power plant represent a "significant" impact on the population of a certain species, or on the ecosystem as a whole. These states are setting a very high burden of proof. Study designs and results are contentious, and it is very difficult to attribute cause and effect to events that occur in large, complex ecosystems affected by many environmental stressors. Unsurprisingly, states that rely on such biological studies typically take little or no action to reduce fish kills. This approach violates the Clean Water Act.

The EPA long ago decided (and the courts agreed) that the "adverse environmental impacts" that the Clean Water Act requires it to address are the killing of millions of fish and eggs.[33] Regulators are not required to find that these fish kills have some effect on overall ecosystem population before they constitute an "adverse environmental impact." In fact, looking for such overall impact on the receiving water's wildlife levels is illegal. A focus on overall fish populations and environmental harm effectively turns Section 316(b) of the Clean Water Act into a water quality-based approach to regulating cooling water intakes and ignores the principle that power plants should use "the best technology available" to reduce adverse impacts on fish and eggs.[34]

There is a simple reason that Congress made this approach of waiting for evidence of "significant" impact on the wider environment illegal: it doesn't work. As EPA notes, "it is very difficult to assess the cause and effect of cooling water intake structures on ecosystems or on important species within an ecosystem."[35] Looking for population or ecosystem effects leads to "paralysis by analysis." According to EPA:

> An overwhelming majority of scientists have stated that biological studies can take multiple years because of the complex nature of biological systems. Moreover, unlike in the laboratory, where conditions are controlled, a multitude of confounding factors make biological studies very difficult to perform and make causation, in particular, difficult to determine. [36]

The New York State Department of Environmental Conservation (DEC) agrees that ecosystem or population level environmental assessments of once-through cooling systems leads to "potentially endless, expensive studies that usually yield ambiguous or debatable results … because it is impossible to identify, measure, and attribute the impact of each [of] the many variables affecting populations on each of the impacted species."[37] And the former head of power plant permitting in Michigan has written that "My experience indicates that studies of the effects of cooling water intake structures on the receiving water fisheries are extremely difficult to do and the results are difficult to interpret."[38] Similarly, the New Jersey Department of Environmental Protection believes that:

> State agencies and permitting authorities could engage in a debate for years as to the population measure of a given fish species,

> let alone many fish species. The results of biological population studies and modeling can be very subjective because it is difficult to identify, measure, and attribute the impact of each of the many variables ... affecting populations of each of the impacted species.[39]

When Congress passed the Clean Water Act in 1972, it explicitly ordered states to use the best technology available to minimize the adverse environmental impacts of cooling water systems. The stress on the use of the best technology was deliberate.

In the decades before passage of the Clean Water Act, state governments often did not act to control pollution because, with many polluters killing fish in the same river or harbor, state officials could not prove in court that any single polluter was responsible for the declining conditions and obvious environmental harms in state waters. As a result, power plants such as New York's Indian Point nuclear power plant killed incredible numbers of fish, Cleveland's Cuyahoga River caught fire and vast areas of iconic American waterbodies like Lake Erie, New York Harbor and the Chesapeake Bay became almost incapable of supporting life. Congress designed the Clean Water Act to let states focus on environmentally protective technology, and to eliminate the need to prove that one polluter alone has a significant impact on a whole ecosystem.

Regulators in the best performing states avoid population and ecosystem level paralysis. These regulators have discovered that they are more successful at protecting overall ecosystem health by focusing on technology that can minimize impingement, entrainment and thermal discharge from power plants. Based on this experience, New York has asked EPA to promulgate "clear performance based requirements" that set "nationally-applicable minimum standards" so that "companies and regulators could put their staff and monetary resources into reducing impacts instead of into studies and rebuttals."[40]

2. PERIODIC RECONSIDERATION OF BTA DETERMINATIONS: REVIEW WITH EVERY PERMIT RENEWAL

Under the Clean Water Act, states must reissue each National Pollutant Discharge Elimination System (NPDES) permit every five years. Thus, every five years, a state environmental agency that regulates an old power plant must assure itself that the plant is meeting *all* of the Act's requirements — including the requirement to use the best technology available to minimize the environmental harm, e.g. the killing of fish and eggs, caused by cooling systems.

When Congress passed the Clean Water Act in 1972, it explicitly ordered states to use the best technology available to minimize the adverse environmental impacts of cooling water systems.

Some state agencies comply with the law by reviewing the BTA determination every time that an old power plant's NPDES permit is renewed. The best states are also proactive — they set clear policies that call for old power plants to stop killing billions of fish and other organisms and start using closed-cycle cooling systems that protect the environment. And they use each permit renewal as an opportunity to advance that policy as appropriate. As a consequence, in states like New Jersey and Delaware, state permit writers, engineers and biologists have recent experience evaluating cooling water systems and the ecological and engineering studies submitted by power plants.

In contrast, other states approved the use of once-through cooling systems at dozens of power plants in the 1970's and 80's, and have never revisited those decisions. These states are violating federal law. The Clean Water Act requires that the restrictions on cooling water intakes be reviewed with every permit renewal.[41]

Now, these state agencies face a backlog of plants that will need to be re-examined under EPA's new rule with little or water no institutional memory or experience.

3. BIOLOGY EVALUATION PROCESS: CUMULATIVE IMPACTS TO ALL SPECIES

While the best performing states focus on applying the best technology to reduce fish kills, they do not ignore the ecological harm caused by cooling systems. Instead, these states recognize that cooling water intakes cause harm to all species of fish and to the ecosystem as a whole. On the other hand, some of the worst-performing states look only at the killing of "species of concern," a policy that allows state officials to ignore the killing of many of the prey species (known as forage fish) that make up the bulk of the fish population in every aquatic food chain.

Another ecological best practice, one explicitly recommended by EPA, is for state regulators to conduct careful cumulative impact analyses rather than looking at a cooling system in isolation. Cumulative impact

analysis considers the overall harm to fish populations in a waterbody caused by multiple cooling water intakes located within the same watershed, on the same waterbody, or along the same migratory path for a fish species, as well as the impacts of these fish kills in combination with other environmental stresses.

EPA has determined that more than 99 percent of existing power facilities are located within 2 miles of a waterbody that fails to meet state water quality standards.[42] Thus EPA warns that, in almost every case,

> CWIS [cooling water intake structure] impacts do not occur in isolation from other ongoing physical, chemical, and biological stressors on aquatic habitats and biota in the receiving waterbody. Additional anthropogenic stressors may include but are not limited to: degraded water and sediment quality, low dissolved oxygen (DO), eutrophication, fishing activities, channel or shoreline (habitat) modification, hydrologic regime changes, invasive species, etc. For example, many aquatic organisms subject to the effects of cooling water withdrawals reside in impaired … waterbodies. Accordingly, they are potentially more vulnerable to cumulative impacts from other anthropogenic stressors. The effect of these anthropogenic stressors on local biota may contribute to or compound the local impact of I&E [impingement and entrainment] mortality ….[43]

4. COMPARING COSTS AND BENEFITS: CONSIDER ALL OF THE BENEFITS FAIRLY

Although states are not required to undertake cost-benefit analyses under the Clean Water Act, EPA's proposed new rule encourages states to compare the monetized social costs and benefits of technologies that reduce fish kills before selecting the best technology available. But EPA's rule does not specify how these costs and benefits should be compared, only that states may reject technologies such as closed-cycle cooling if they determine that the benefits do not justify the costs.

The ambiguous instruction to compare costs and benefits ignores a massive informational gap. Accurately comparing the costs and benefits of protecting aquatic ecosystems is extremely difficult. The costs of closed-cycle cooling systems and other technologies can be measured in dollars with a reasonable degree of accuracy and completeness. But the benefits of saving fish and protecting aquatic ecosystems are diverse and much harder to measure.

America's lakes, rivers, estuaries and harbors provide food, livelihoods and recreational opportunities for hundreds of millions of people. And a healthy aquatic ecosystem also provides aesthetic, spiritual and cultural benefits to society. A small fraction of these benefits can be directly measured in dollars. For example, some species of fish are commercially valuable and can be assigned a market price. But the U.S. EPA estimates that less than 3 percent of the fish saved by closed-cycle cooling systems have commercial or sportfishing value.[44] Preventing the other 97 percent of the harm to aquatic life caused by old once-through cooling systems provides benefits that are literally priceless and that reinforce many of our core values: protection of life, health, natural ecosystems and biodiversity.

Indeed, in developing its new cooling water rule, EPA listed entire and substantial categories of "non-use" benefits of the rule that were beyond its capacity to measure or monetize.[45] For example, many of the non-commercial species of fish killed by cooling water intakes are critical links in the aquatic food chain and their presence and health is necessary to ensure that ecosystems are resilient and thus better able to withstand other stresses, such as climate change. Protecting these fish is an investment in the health of the entire ecosystem.

While there is no market in which such benefits can be purchased, the choices that Americans make every year demonstrate the high value we place on protecting fish, aquatic ecosystems, and the broader natural systems that they support. In an ever busier world, Americans choose to spend much of their limited and valuable free time in nature, collectively spending many billions of dollars every year on travel, equipment (fishing gear, boats, cameras, camping supplies), park fees, lodging and other related expenses that enable us to access and enjoy rivers, lakes, estuaries and harbors. According to the U.S. Fish and Wildlife Service, more than 90 million U.S. residents (16 years old and older) participated in some form of wildlife-related recreation in 2011, spending a total of $144.7 billion in 2011 on their activities, which is equal to 1 percent of GDP.[46] We also pay for habitat conservation through taxes, and we donate land or money to nature preserves and conservation groups. And there is broad, consistent, public support for laws that require polluting industries to invest in environmental protection.

Finally, aquatic ecosystems are also valuable as a breeding ground and habitat for commercially valu-

able species of fish. And many of the non-fished species that live in these systems are still valuable members of a food chain that supports the commercially-fished species. A global study by the Lenfest Forage Fish Task Force estimates that, looking only at their role as a food source that sustains commercial fisheries, "forage fish" are worth more than $11 billion.[47]

States have several options for factoring costs and benefits into their BTA determinations. One common approach is to adopt an economic feasibility test, in which a state requires that polluters install the most environmentally protective measures that are affordable.

Delaware conducted a comprehensive affordability test before concluding that the Delaware City Refinery power plant, located on the Delaware River, should upgrade to a closed-cycle cooling system.

New York, another best practice leader, uses a "wholly disproportionate" standard to compare the costs and benefits of closed-cycle cooling and other technologies:

> After selecting the best technology available for an industrial facility, the Department will consider the cost of the feasible technologies and will determine *whether or not the costs of the technologies are wholly disproportionate to the environmental benefits to be gained from the technology.* The Department will not undertake a formal cost-benefit analysis whereby the environmental benefits would be monetized. Such an analysis is neither desirable nor required by law. For each site specific BTA determination, the Department will select a feasible technology whose costs are not wholly disproportionate to the environmental benefits to be gained.[48]

This "wholly disproportionate" standard originates with the U.S. EPA, which began using it in the late 1970's.[49]

In contrast, many of the states that have done little to modernize their power plants in 40 years rely on the monetary cost-benefit analyses submitted by power plant operators. These studies try but fail to convert into dollars all of the costs and benefits of saving fish.

At a national level, EPA's monetized cost-benefit analysis shows that closed-cycle cooling systems are a worthwhile investment: the total social benefits of modernizing power plants significantly exceed the total social costs. But experience shows that trying to replicate this large-scale analysis at the level of individual cooling water intakes is completely unworkable because the analyses submitted by power plants to regulators are universally inadequate and incomplete. Power plants submit (and states accept) studies that consider any non-commercial species of fish to be worthless and that assign no value to improving the resilience, overall health and biodiversity of waterbodies. Because 97 percent of the fish saved by closed-cycle cooling systems have no direct commercial value, power plant owners and operators simply "zero out" almost all of the benefits of closed-cycle cooling.[50] Unsurprisingly, the power plant owners and operators always conclude that paying to modernize their facility is unjustified.

Thus, the way that states compare the costs and benefits of modernizing cooling systems is another critical factor in separating best and worst practices. The states that have done the most to end fish kills — saving Americans billions of dollars a year in avoided natural resource damages — rely on economic feasibility tests, or on ensuring that the benefits and costs of environmental protection are not wholly disproportionate. But states that rely on distorted cost-benefit analysis simply (and needlessly) empower old power plants to keep killing fish.

5. INTEGRATING ENERGY SECURITY AND ENVIRONMENTAL PROTECTION

Many states appear to miss the link between energy security and environmental protection. When an old plant installs closed-cycle cooling to meet modern industrial standards, it doesn't just solve environmental problems, it also increases the reliability of the power grid. Recently, power plants from Connecticut to Texas have had to go off line because the waters the plant relies on for cooling were too warm to use in their once-through systems. Across the country, plants have turned to emergency intakes, held back water in reservoirs that may be more urgently needed downstream, and in extreme cases have even been forced to curtail operations. This is not a one-time problem. Over this century, climate change is expected to drive more frequent and more intense extreme weather events.[51]

Plants that rely on natural waterbodies to provide once-through cooling water need a large volume of water, and they need that water to be at or below a critical temperature, which is determined by the design of the plant's cooling system. Climate modelers expect that, during hot periods, natural waterbodies throughout the United States will simultaneously experience lower flows and hotter water temperatures.

Combining these two effects, an international team of climate modelers and energy experts writing in the June 3, 2012 edition of the science journal Nature Climate Change concluded that, by the 2040s, U.S. power plants with once-through cooling systems will need to adapt their cooling systems or risk decreases of average summer usable capacity of 12 – 16 percent.[52] Unfortunately, these capacity losses come at the hottest time of year, when the demand for — and the price of — electricity are at their peaks. Reduced power output from older plants at these crunch times could both threaten power supplies and sharply increase market-clearing prices.

State regulators, particularly those in drought-prone areas, should consider the energy security benefits of requiring an old power plant to upgrade its cooling system. Although EPA's new rule only requires states to look at fish kills, nothing prevents states from taking a more holistic perspective in reviewing cooling water systems. States are free to simultaneously consider the adverse impact of water withdrawals, thermal pollution, the release of biocides and corrosion-fighting chemicals, and the energy reliability benefits of reducing a power plant's dependence on large volumes of cooling water. Such an integrated analysis would more accurately reflect the social benefits of modernizing old power plants. Unfortunately, it seems that most states analyze "energy" and "the environment" separately, to the detriment of both.

6. RECLAIMED WATER: USE IT, DON'T LOSE IT

Power plants in many states voluntarily use reclaimed water from municipal sewage plants to reduce or eliminate their withdrawal of cooling water from lakes and rivers. For example, since the 1960s San Antonio's wastewater treatment plant has been providing water to the city's energy utility, now providing up to 16 billion gallons per year for power plant cooling.[53] The Palo Verde Nuclear Generating Station in Arizona uses more than 20 billion gallons of treated sewage effluent annually from the City of Phoenix for its cooling water.[54]

Despite these and other successful examples of cooperation between water and energy utilities, only 60 power plants in the U.S. get their cooling water from treated municipal wastewater sources.[55] Far more reclaimed water is available for use. 90 percent of U.S. power plants currently using reclaimed water get it from a facility within 25 miles, and the average distance of all facilities from their reclaimed water source is approximately 7.5 miles. A 445-page detailed, multi-year report conducted for the Department of Energy found that 75 percent of existing coal-burning power plants are within 25 miles of a wastewater treatment plant that could provide water for cooling and concluded that "finding alternative water resources to replace freshwater demand for cooling purposes is inevitable and urgent."[56] Similarly, a 2009 National Energy Technology Laboratory study concluded that "[r]eclaimed water (treated municipal wastewater) is widely available in communities throughout the United States in sufficient volumes and is reliable enough to supply power plant cooling water."[57] And a 2008 study by the Electric Power Research Institute found that "[m]unicipal effluent due to its abundance and quality is a viable alternative source for cooling water supply."[58]

Although all regulators welcome this kind of water reuse, only California has adopted a formal policy encouraging industry to reuse reclaimed water.[59] Other states may be able to increase water reuse and reduce fish kills by following California's example and establishing an official state policy that requires or rewards reclaimed water use.

Collaboration and coordination between municipal wastewater and electric utilities holds great potential. According to a 2009 study, 50 percent of existing power plants could obtain all of their cooling water from wastewater treatment plants within a 10 mile radius, and that jumped to 76 percent when extending the radius to 25 miles.[60]

7. WRITTEN POLICIES AND PROCEDURES: CLEAR, CONSISTENT, TECHNOLOGY-FOCUSED PRACTICES

Written policies and procedures for BTA determinations ensure consistency from plant to plant. These policies also record institutional knowledge so that decades of experience are not entirely lost when key staff retire. A written policy also helps permit-writing staff to streamline the BTA process and verify that all needed data is at hand. Further, making a BTA determination requires a mix of biological, engineering, and economic analysis expertise. A good written policy will let staff know where to seek help when dealing with an area beyond the permit writer's expertise.

In the past, all of this was perhaps less important in some states because BTA determinations were few and far between. But now, under EPA's new rules, many states will be forced to play catch up and issue multiple (in some cases dozens of) BTA determinations in just a few years. Clear, consistent guidance and decision making processes will help states to meet federal deadlines.

8. DATA GATHERING

Making a well-informed, site-specific BTA determination requires data—at the very least, it takes information about the ecosystems affected, the numbers and species of organisms killed and the timing of those deaths, and the technology options available to reduce this harm. Much of EPA's proposed rule is concerned with specifying the kinds of studies that permittees must submit to state regulators in order for those regulators to make informed BTA determinations.

Under EPA's new rule, power plant owners will need to submit these studies on fixed deadlines. Thus, state data gathering practices will not be as relevant as they are today. But until EPA's rule is finalized, current state data gathering practices remain important. And even under the new rule, not every power plant owner will submit adequate studies that answer all of a careful regulator's questions. A state's current willingness to seek out information from regulated facilities may be a reasonable predictor of that state's future performance.

Some states gather large volumes of data and do so very slowly, to the point that it appears they may be deliberately using information gathering as a stalling tactic to avoid making BTA determinations. Regulators may only ask permittees to submit data on intakes or ecosystem health in connection with a NPDES permit renewal—i.e. on a five-year cycle. And in some cases, these data requests have been strung out over multiple permit cycles when they could have been consolidated into one cycle.

In contrast, the best regulators understand what information they need, where the data gaps are, and make a focused effort to get it. All of the agencies that issue NPDES permits have authority under Section 308 of the Clean Water Act to require at any time that a regulated facility provide more information. Most state regulators also have similar power under state law. The best regulators use this authority to ask regulated facilities for information when needed and, as a result, are capable of making BTA determinations in less than five years—i.e., within a single NPDES permit cycle.

BEST AND WORST PRACTICES: A GUIDE

The following Guidelines are drawn from our review of state permitting practices. They provide a template for readers to analyze whether their state's approach to making BTA determinations for cooling water intakes is consistent with Section 316(b) of the Clean Water Act and can achieve meaningful environmental protection.

BEST AND WORST PRACTICES: A GUIDE		
PRACTICE AREAS	**BEST PRACTICE**	**WORST PRACTICE**
No. 1: Technology Evaluation Process	Promoting closed-cycle cooling as the default level of protection; lesser technologies are not "good enough." Carefully scrutinizing regulated party claims that closed-cycle cooling is not technically feasible.	Allowing regulated facilities to adopt the technology that they suggest without scrutiny. No consideration of closed-cycle cooling. Using a fictional "full-flow" baseline to measure reductions in environmental harm
No. 2: Periodic Reconsideration of BTA Determinations	Reconsidering controls in use at every facility that does not use closed-cycle cooling with every permit renewal.	No reconsideration of BTA determinations made decades ago.
No. 3: Biology Evaluation Process	Considering harms to all organisms, and to the ecosystem as a whole. Cumulative impact analysis of multiple intakes and other environmental stresses. Analyses based on recent impingement and entrainment data.	Protecting only "valued" species or "species of concern" (the rest are "garbage fish"). Basing analysis on modeling or sampling that is years out of date. Looking for proof of population level effects before acting to protect fish.
No. 4: Comparing Costs and Benefits	Requiring old plants to use the most environmentally protective technology as long as it is economically feasible. Applying a "wholly disproportionate" standard that ensures protection and avoids absurd results. Rejecting benefit-cost analyses that fail to consider the full suite of benefits.	Basing decisions on incomplete benefit-cost analyses that exclude 98 percent of all environmental benefits.
No. 5: Integrating Energy Security and Environmental Protection	Considering the cumulative benefits of reducing thermal pollution, avoiding fish kills, and enhancing the resilience of energy infrastructure before issuing a NPDES permit.	Each benefit of closed-cycle cooling is considered in isolation, sometimes by different agencies or different offices, to see whether it justifies a closed-cycle cooling retrofit.
No. 6: Reclaimed Water	Requiring plants to use any available reclaimed water to reduce or eliminate fresh water withdrawals.	Do not consider reclaimed water.
No. 7: Written Policies and Procedures	Clear, written policies for regulated parties and agency staff that record the state's experience and practices. Policy requires closed-cycle cooling where technically feasible and affordable. Permit writers draw on agency expertise or outside consultants with experience in aquatic biology and ecology, economics and engineering.	No formal policies. All institutional knowledge resides with a single staff member. Policies that declare fish kills not to be "adverse" or "significant" environmental impacts absent proof of population-level or ecosystem-wide harm. Permit writers decide each case alone, without help from experts in other fields.
No. 8: Data Gathering	Using authority under the Clean Water Act and state law to demand information as required. Gathering all data required for a BTA determination within a single NPDES permit cycle.	Gathering limited data through the NPDES renewal process, with few or no other data requests. Gathering data slowly, over multiple NPDES permit cycles.

PART THREE: STATE EVALUATIONS

Using freedom-of-information laws, the authors obtained relevant documents from permitting agencies. Follow-up interviews with agency staff were conducted to the extent staff were available to discuss their cooling water intake permits, laws, regulations and policies. This report covers 10 states as well as EPA Region 1 which issues Clean Water Act permits for two states in New England. State BTA determination policies are compared on six factors:

- EASE OF EXECUTION Has the state established a process that leads to relatively speedy and uncomplicated BTA determinations? Of course, a simple process is not always a virtue: states that do little or nothing to control fish kills generally have a very simple process—they refuse to revisit BTA determinations made decades ago, or conduct only the most perfunctory analysis. But having a straightforward process for making BTA determinations will be important under EPA's new rule because some states will receive dozens of power plant studies within a short period of time and must then make several BTA determinations simultaneously in order to issue water pollution permits in a timely manner.
- TECHNOLOGY EVALUATION PROCESS Does the state require the use of closed-cycle cooling where feasible? Does the state at least consider the use of closed-cycle cooling at every old power plant? Where different technology options for reducing fish kills are considered, how does the state rank and choose between them? Is monetized cost-benefit analysis used at individual sites and, if so, how does the state require power plants to account for the significant non-market values of fish and ecosystems?
- BIOLOGY EVALUATION PROCESS Do the state's NPDES permits and correspondence with old plants indicate that the state closely and critically reviews ecological and biological studies? Does the state look at the effect of a cooling water system in isolation, or does it also consider the cumulative impacts of other environmental stresses on a waterbody? Above all, does a search for population-level or ecosystem-wide ecological impacts create paralysis in a state's BTA determination process?
- RECONSIDERATION OF PAST BTA DETERMINATIONS Does the state follow the requirements of the Clean Water Act by meaningfully reviewing the BTA determination for an old power plant each time that the plant renews its NPDES permit? Failing that, does the state at least conduct a meaningful review periodically? Is the state proactively seeking to end the use of once-through cooling, or waiting until it becomes aware of information that forces it to act?
- WRITTEN POLICIES AND PROCEDURE Does the state have a written policy that directs staff on the process of making BTA determinations? Does the policy ensure consistency and capture institutional knowledge? And does the policy explicitly favor a technology-based approach in general, and in particular, the use of closed-cycle cooling?
- GATHERING DATA Does the state have a robust process for gathering data about cooling water intakes in a timely fashion? Does the state wait for power plant operators to provide information when they apply for renewals of their water pollution permits, or has the state taken action to obtain information on its own?

These six factors are based on, but differ slightly from, the Best Practice Areas identified in Part 2 of this report. Not all of the best practices identified above work as meaningful points of comparison between the states surveyed. For example, California is the only state with a reclaimed water policy. And while "Ease of Execution" is an important consideration for states seeking to adopt a workable approach to making multiple BTA determinations in the coming years, a straightforward BTA determination process is not itself a best practice, it is a result of adopting best practices.

A summary of our findings for each state follows.

CALIFORNIA

OVERALL ENVIRONMENTAL PROTECTION: **HIGH**
In establishing a statewide BTA policy, determining that closed-cycle cooling is the best technology available for all 19 plants, and in requiring the submission of implementation plans as a condition of the Policy (rather than waiting for NPDES permits to come up for renewal), California has set the bar in terms of best practices by states.

OVERVIEW OF CALIFORNIA: In 2010, the California State Water Resources Control Board (commonly called the State Water Board) adopted a statewide policy that will gradually phase out the use of once-through cooling systems at all 19 existing coastal and estuarine power plants in the state.[61] Those plants, which include 17 fossil-fueled and two nuclear plants, have the ability to withdraw over 15 billion gallons of seawater per day. After an extensive technical and economic review that included cost evaluations for retrofitting each plant, California selected closed-cycle cooling as the best technology available to control impingement and entrainment (and to reduce thermal pollution) at all 19 plants subject the Policy.

The Policy, portions of which are codified in a state regulation,[62] sets a statewide standard of 93-percent reduction in use of seawater through a two track compliance system:

> **Track 1:** Plants must reduce their intake flow rate to a level commensurate with that which can be attained by a closed-cycle wet cooling system, with a minimum 93 percent reduction. In addition, intake velocity must not exceed 0.5 foot per second. Dry cooling systems meet the minimum reduction requirements of Track 1, but are not required.
>
> **Track 2:** If plant owner can demonstrate to the State Water Board's satisfaction that compliance with Track 1 is "not feasible," the plant must use operational and/or structural controls to reduce impingement mortality and entrainment to a "comparable" level (defined as 90 percent or more) of that which would be achieved under Track 1, as demonstrated through specified biological monitoring studies.

In order to demonstrate infeasibility that would entitle a plant to Track 2, its owner or operator must show that Track 1 "[c]annot be accomplished because of space constraints or the inability to obtain necessary permits due to public safety considerations, unacceptable environmental impacts, local ordinances, regulations, etc. Cost is not a factor ..."[63] Somewhat incongruously, the Policy allows plants with combined-cycle power-generating units installed prior to October 2010 to select Track 2 without making such a showing. That aspect of the Policy may result from an unusual situation — while the vast majority of combined-cycle natural gas power plants have closed-cycle cooling, there are a few in California that do not.

The Policy contains a schedule for all 19 plants to comply. As originally adopted, the final compliance dates for the fossil-fueled plants were staggered from 2010 through 2020. However, in 2011, the State Water Board amended to the Policy to extend the deadlines for certain plants in Los Angeles until 2024 and 2029. Further modifications to the compliance dates for these plants are possible by the end of 2013, based on additional information submitted by the Los Angeles Department of Water and Power.

The Policy also has special provisions for the nuclear plants, San Onofre and Diablo Canyon. First, if either plant can demonstrate that compliance with the Policy would conflict with a safety requirement established by the Nuclear Safety Commission (NRC), the State Water Board will make a site-specific determination of best technology available for that plant. Second, the State Water Board may also establish alternative, site-specific requirements for either nuclear plant based on special studies to be conducted by an independent third party engineer selected by the State Water Board. The studies will be overseen by a Review Committee for Nuclear Fueled Power Plants (RCNFPP), established to investigate ability, alternatives and cost for those plants to meet the Policy requirements. The final compliance dates for San Onofre and Diablo Canyon are 2022 and 2024, respectively.

The Policy also requires interim measures to reduce impingement and entrainment while the plants' final BTA measures are being planned and implemented. For example, plants with offshore intakes are required to immediately install "large organism exclusion devices" to protect aquatic life such as marine mammals and sea turtles and to turn off their intake pumps when not generating power or engaging in critical system maintenance that requires intake flow. The 2011 amendment to the Policy also requires plants with compliance dates after 2022 to: (i) commit to eliminating once-through cooling and seawater use for cooling water purposes for all units at the facility;

(ii) conduct a study to evaluate new technologies or improve existing technologies to reduce impingement and entrainment; (iii) submit the results of the study and a proposal to minimize entrainment and impingement by 2015; and (iv) upon approval of the proposal, complete implementation of the proposal no later than December 31, 2020. It is not clear how the proposal to be implemented by 2020 differs from the BTA measures that are to be installed after 2022, since both must minimize entrainment and impingement.

As a first step in compliance, the State Water Board received implementation plans in 2011 from all 17 fossil-fueled power plants, identifying their selected compliance alternative (i.e., Track 1 or Track 2), describing the measures that will be undertaken to implement the alternative, and proposing a realistic schedule that is as short as possible. The State Water Board has made these plans available on-line.[64] Most have informed the State Water Board that they are planning to modernize their plants' equipment and will switch to air ("dry") cooling systems. Some have chosen to use wet evaporative cooling cells. Others are pursuing alternative controls, such as screening under Track 2.

The Policy is to be implemented through issuance of NPDES permits. The Policy requires the permits to incorporate a final compliance deadline no later than the applicable deadline contained in the Policy, unless the State Water Board determines that a longer compliance schedule is necessary to maintain reliability of the electric system while other plants are retrofitted, repowered, or retired or transmission upgrades take place. To inform that decision the state has convened a Statewide Advisory Committee on Cooling Water Intake Structures (SACCWIS) to advise the State Water Board on the implementation of the Policy and ensure that it will not cause disruption to the State's electrical power supply. The SACCWIS includes representatives from the California Energy Commission, California Public Utilities Commission, California Coastal Commission, California State Lands Commission, California Air Resources Board, California Independent System Operator, and the State Water Board.

The State Water Board's concern with disruption to the electricity supply seems to be an overreaction to the electricity crisis in the late 1990s that contributed to the recall of former Governor Gray Davis. A Federal Energy Regulatory Commission investigation subsequently found that energy trading companies had illegally restricted power supply, causing spikes in usage to cause blackouts. Nonetheless, state officials have included numerous contingencies in the Policy to ensure that no disruption shall occur, including staggered compliance dates and the SACCWIS process.

FACTORS

EASE OF EXECUTION: **RELATIVELY EASY.**
A statewide policy means that the State Water Board does not have to reinvent the wheel 19 times, once for each plant. This ease of execution is somewhat undermined by allowing certain plants to opt for Track 2 even if Track 1 is feasible.

TECHNOLOGY EVALUATION PROCESS: The Policy is technology-driven, requiring closed-cycle cooling, defined as a minimum 93 percent reduction in seawater withdrawal, and imposing an intake velocity limit. The second track is also technology-based, requiring performance at least 90 percent as protective of aquatic organisms

BIOLOGY EVALUATION PROCESS: Biological factors come into play in determining whether impingement and entrainment have been reduced to a level at least 90 percent of that which would be achieved with closed-cycle cooling. Although the Policy does not refer to impingement survival, the reference to impingement mortality implies that for Track 2 the State Water Board may need to review impingement survival studies and make related plant-specific determinations regarding which species may survive impingement at what levels.

RECONSIDERATION OF PAST BTA DETERMINATIONS: The Policy requires reconsideration of each past BTA determination for the 19 plants.

WRITTEN POLICIES AND PROCEDURES: The Policy, codified as a regulation, is the best and most authoritative type of written document a state can develop to guide NPDES permit decisions.

GATHERING DATA: The Policy calls for implementation studies for all 19 plants, each of which was submitted in 2011.

RECLAIMED WATER: The Policy states that: "To conserve the State's scarce water resources, the State Water Board encourages the use of recycled water for cooling water in lieu of marine, estuarine or fresh water."

CONNECTICUT

OVERALL ENVIRONMENTAL PROTECTION:
UNKNOWN

Because Connecticut has not issued its statewide BTA policy and has not made recent BTA determinations, it is hard to assess the level of environmental protection. Judging upon the basis of the currently effective permits, many of which are expired and administratively continued, the level of environmental protection is low. Connecticut has never required a power plant to retrofit to closed-cycle cooling, although the state Department of Energy and Environmental Protection informally released a tentative determination for the Millstone Nuclear Power Station in 2007 that would have required closed-cycle cooling.

OVERVIEW OF CONNECTICUT: Connecticut has one large nuclear plant, the Millstone Nuclear Power Station, which supplies roughly half of the state's power, withdraws more than two billion gallons per day from Long Island Sound, and entrains and impinges far more fish than any other plant in the state. It also has one coal-fired unit, located at the Bridgeport power plant, and many relatively small, older, inefficient oil/gas plants that do not operate frequently.

The Millstone plant operated for more than 17 years on a 1992 NPDES permit that expired in 1997 and was administratively continued until 2009. Upon issuance of the 1992 permit, the Connecticut Department of Energy and Environmental Protection (DEEP) called on the plant owner to study the feasibility of a variety of technologies that could minimize the fish kills. The permittee submitted a detailed study in 1993 and another in 2001, each of which found closed-cycle cooling to be the most protective technology and technically feasible to install at the facility. Nevertheless, in 2009, upon renewal and modification of Millstone's NPDES permit, DEEP did not require closed-cycle cooling. Rather, the Department required the plant to install interim measures to reduce impingement and entrainment and to prepare and submit two more comprehensive studies (One technological and one biological) to inform a subsequent BTA determination by DEEP. The plants' NPDES permit is expected to be modified again to incorporate the subsequent BTA determination when made by DEEP. The technology study on which DEEP will base its BTA evaluation must include an assessment of closed-cycle cooling systems capable of reducing intake flows by 90 percent or more. The required interim measures include variable speed pumps that moderately reduce the intake of cooling water and timed outages, i.e., regular refueling downtime is scheduled during the peak spawning season in the spring.

DEEP has also requested that all of the other power plants in the state submit technological and biological studies similar to those being prepared for the Millstone plant. Other than the partial, interim BTA determination for Millstone, DEEP has not made any in-depth BTA determinations. Virtually all of the plants operate on older permits that allow once-through cooling and the Department has not evaluated the feasibility of retrofitting these plants to closed-cycle cooling.

Connecticut has no written BTA regulations, policies or procedures, but intends to initiate a process to develop a statewide BTA policy after the U.S. EPA issues its upcoming regulations. Although there is currently no written policy, DEEP takes the position that it will base its BTA determinations in part on the plant's operational characteristics. For example, if peaking or load-following plants agree to limits on the percentage of time they can be dispatched, DEEP may be willing to exercise some flexibility with respect to the technology retrofits required. Conversely, if plants that do not run often wish to preserve the ability to run 24/7/365, they will be treated the same as baseload facilities.

DEEP involves its Department of Marine Fisheries in reviewing power plant intake structures. In addition, DEEP entered into an agreement with the owner of the Millstone plant to provide funds for DEEP to hire outside engineering and biological consultants to assist Department staff in its technical review. DEEP's position is that it will consider the impact of power plants on all fish and shellfish species and not limit its review to only certain "species of concern." DEEP has not yet decided what role cost should play in its BTA determinations. Presumably this will be determined in its upcoming policy.

With no written policy and no recent, complete BTA determinations, it is hard to gauge Connecticut's practices. The state is generally taking its time, asking the plants to gather as much information as possible, hoping that EPA will set national standards that would ease the burden on state decisionmakers and planning to develop a policy once EPA has acted.

FACTORS

EASE OF EXECUTION: **HARD**. In the absence of a policy or a track record in making BTA determinations, each NPDES permit will have to be issued on a completely case-by-case basis until a policy is developed. The policy will undergo a stakeholder process, which may be long and cumbersome, before being issued. Development of a statewide policy is particularly concerning given that DEEP has not started drafting it yet, and thus timely compliance with EPA's deadlines could be a problem.

TECHNOLOGY EVALUATION PROCESS: Based on the information DEEP requires from permittees, it appears as though Connecticut plans to make technology-based determinations rather than looking for an acceptable level of impact. In letters to permittees, DEEP has stated that EPA and other permitting authorities have identified closed-cycle recirculation systems as the most effective technology to minimize adverse environmental impacts and reflects BTA for existing power generating facilities. DEEP thus requires all power plants to submit a comprehensive evaluation of all technological and operational measures, individually or in combination, for minimizing adverse environmental impacts, including but not limited to closed-cycle cooling.

BIOLOGY EVALUATION PROCESS: DEEP staff has stated that it will consider impacts on all species of fish. In letters to permittees requesting impingement and entrainment data, DEEP seeks information regarding the degree and extent of mortality of all life stages of fish, shellfish and wildlife in and on the body of water in the vicinity of the facility's cooling water intake structures.

RECONSIDERATION OF PAST BTA DETERMINATIONS: DEEP has not yet reconsidered the BTA determination in any of its older permits.

WRITTEN POLICIES AND PROCEDURES: DEEP does not have written policy guidance yet, but plans to develop a BTA policy.

GATHERING DATA: With the exception of the Millstone permit, DEEP uses simple letters or Section 308 letters issued by EPA Region 1 to direct permittees to gather data. DEEP's data acquisition process is quite slow. DEEP has been gathering 316(a) and 316(b) data for several power plants over an extended period of time. In conjunction with the fact that DEEP did not intend to begin developing a statewide BTA policy until EPA's rules are final, this appears to have be a stalling tactic to run out the clock while DEEP waited for EPA to act. EPA has explicitly instructed states not to cause such delays, and instead to use their best professional judgment to make BTA determinations in the absence of a federal rule.

DELAWARE

OVERALL ENVIRONMENTAL PROTECTION:
UNKNOWN, BUT HIGH POTENTIAL

Delaware claims to be gradually pushing the largest cooling water users in the state to closed-cycle cooling, the best technology available. But the problem is that, so far, Delaware has talked a good game, but has not delivered. For example, Delaware prepared an excellent draft BTA determination for the Delaware City Refinery, but a final NPDES permit that incorporates this BTA determination has been long delayed. State action is critical to restoring a vibrant and healthy living community along one of America's historic waterways, the Delaware River.

OVERVIEW OF DELAWARE: Delaware is a small state with only a few older power plants that still rely on once-through cooling. But because these plants are located in a productive coastal estuary, their once-through cooling systems have a very significant biological impact. Once-through cooling on the Delaware River (including plants on the New Jersey side on the river) kills more commercially valuable fish than are landed by the state's commercial fishing fleet, as well as billions of other non-commercial fish and aquatic organisms.

Delaware's government recognizes the dire impacts of once-through cooling systems on Delaware's environment and strongly encourages the use of closed-cycle cooling. The state legislature has even called on the neighboring state of New Jersey to follow Delaware's lead by requiring older power plants in that state that were built along the Delaware River to convert to closed-cycle cooling.

Delaware's Department of Natural Resources and Environmental Conservation (DNREC) could be an environmental leader. At the Indian River Power Plant, for example, DNREC worked with the permittee to discontinue the use of the existing closed-cycle cooling system. Recently, DNREC wrote an extremely thorough BTA determination in the draft NPDES permit for the Delaware City Refinery and power plant.

DNREC found that the refinery/power plant could reduce fish kills by more than 90 percent by using closed-cycle cooling. But DNREC has yet to actually take firm action. Indian River decided without compulsion to convert Unit 3 to closed-cycle cooling, and the Delaware City Refinery's NPDES permit has not been renewed, meaning that the draft BTA determination has not taken effect yet.

DNREC does not have a written cooling tower policy or a reclaimed water use policy, perhaps because the regulated community is so small. Even so, DNREC has a consistent approach to cooling systems. Permit writers start by recognizing that closed-cycle cooling is the best performing technology, and asking whether closed-cycle cooling is affordable and technically feasible. DNREC also considers technologies that are less expensive if they come close to achieving the reductions in impingement and entrainment mortalities associated with closed-cycle cooling. To date, DNREC's thorough calculations have showed that closed-cycle cooling is affordable, feasible and the best overall option for Delaware's largest and oldest plants. Although this case-by-case analysis is a heavy burden in tough economic times, DNREC proves that even with relatively limited resources, regulators who streamline their BTA process can write very effective permits.

FACTORS

EASE OF EXECUTION: **EASY.** Delaware claims to have a clear technology-driven approach, but has delayed in implementing it. Delaware recognizes that closed-cycle cooling is the most environmentally protective and widely-used cooling solution. So the state asks three simple questions: Is closed-cycle cooling feasible? Is closed-cycle cooling affordable? And are there any other options that come close to the same level of performance as closed-cycle cooling? Answering those questions takes some work, but the technology focus helps to avoid many permitting pitfalls. The problem has been in the state's lack of follow-through.

TECHNOLOGY EVALUATION PROCESS: DNREC would be a best practice leader in this respect if it acted in a timely manner on pending permits. It begins with the presumption that closed-cycle cooling should be used if affordable and technically feasible because they are the best technology available to protect aquatic ecosystems. DNREC also considers technologies that are less expensive if they come close to achieving the reductions in impingement and entrainment mortalities associated with closed-cycle cooling. DNREC does not have a reclaimed water policy, but has participated in discussion about reusing effluents from wastewater treatment plants to cool smaller industrial facilities.

BIOLOGY EVALUATION PROCESS: DNREC considers each plant's environmental impact on all affected species, not just commercial species of fish. The agency consults with biologists if endangered species may be affected. And instead of looking at each cooling water system in isolation, DNREC considers each plant's impact in light of the cumulative impacts of other cooling water intakes in the Delaware River.

RECONSIDERATION OF PAST BTA DETERMINATIONS: With every permit renewal, DNREC evaluates available information about older power plants and ecosystem health to determine whether a rigorous re-evaluation of the plant's cooling system is justified. In recent years, DNREC has determined that rigorous analysis is warranted with every permit renewal for a once-through cooling system.

WRITTEN POLICIES AND PROCEDURES: DNREC does not have written policy guidance. Nonetheless, DNREC follows a consistent regulatory approach.

GATHERING DATA: DNREC does not limit itself to using the five-year NPDES permit renewal process to gather information. If it needs more information on a permittee's activities or environmental impact, it will write to the permittee and request that information at any point.

EPA REGION 1 (NEW ENGLAND)

OVERALL ENVIRONMENTAL PROTECTION: **HIGH**
EPA Region 1 has required power plants in Massachusetts and New Hampshire to retrofit to closed-cycle cooling or the equivalent.

OVERVIEW OF EPA REGION 1:
In 46 of the 50 states, EPA has delegated NPDES permit writing authority to a state agency. In two of the four non-delegated states — Massachusetts and New Hampshire — NPDES permits are issued by EPA's regional office for New England, known as Region 1.

Region 1 has made relatively recent BTA determinations for four power plants: the Brayton Point Station power plant in Somerset, Massachusetts, the Mirant Canal Station in Sandwich, Massachusetts, the Kendall Station in Cambridge, Massachusetts and the Merrimack Station power plant in Bow, New Hampshire. Region 1 concluded that closed-cycle cooling was the best technology available for three of these plants. At the fourth plant (Kendall), even though Region 1 determined there is not enough room for closed-cycle cooling to be installed at the site, the final permit conditions will achieve a comparable level of protection for aquatic resources by including a new pipeline across the Longfellow Bridge enabling the plant to sell much of its exhaust steam to customers in Boston, thereby reducing its thermal discharge and cooling water withdrawals by approximately 95 percent.

Region 1's BTA determinations for these plants (and other BTA determinations it has made for manufacturing facilities) have been thoroughly researched and carefully documented. The permit determinations document for the thermal discharge and cooling water intake structures at Merrimack Station, for example, runs nearly 400 pages long. Because there are no federal BTA regulations for existing facilities, EPA makes its BTA determinations on a best professional judgment basis without the benefit of written policies or procedures. Nevertheless, the Region's permitting practices are clearly described in the determinations document for each plant.

In determining which of the available technologies is best for minimizing adverse environmental impact, Region 1 looks at the best performing technology in use in the industry or available from among any pertinent transfer or pilot technologies. In addition, Region 1 may (but is not required to) consider the cost of technological options to determine which technologies are available from a financial or economic perspective. In considering costs, Region 1 employs the "wholly disproportionate" test that EPA began using in the 1970s. In this regard, Region 1 has cited with approval an EPA's General Counsel opinion which articulated that test as an evaluation of whether "the present value of the cumulative annual cost of modifications to cooling water intake structures" is "wholly out of proportion to the magnitude of the estimated environmental gains." Those gains include minimizing adverse environmental impacts, restoring and maintaining the physical and biological integrity of the Nation's waters, and achieving, wherever attainable, water quality that provides for the protection and propagation of fish, shellfish and wildlife, and provides for recreation in and on the water. Considering benefits in these terms is a qualitative assessment, rather than a monetized one.

In evaluating costs and benefits, Region 1 considers total project costs and total project benefits to the extent they can be estimated. Region 1 may develop monetized estimates of the benefits and, as appropriate, augment them with qualitative benefits assessments. However, where monetized benefits estimates cannot reasonably be developed due to problems such as information gaps or cost and time constraints, EPA may rely entirely on qualitative benefits assessments or, depending on the circumstances, may eschew any comparison of costs and benefits. One of the reasons that qualitative consideration of benefits may be appropriate is that all relevant benefits may not be subject to monetization.

Beyond considering costs in terms of feasibility or cost/benefit comparison, Region 1 believes that it may (but is not required to) consider the relative "cost-effectiveness" of the available technology options in one of several ways — such as seeking the least expensive way of getting to the same or nearly the same performance goal or by making a comparative assessment of the cost per unit of performance by different options. In determining BTA, Region 1 may also consider additional factors relevant to assessing the benefits and detriments of the available technological options, including the technology's "secondary environmental effects" (e.g., air pollution effects or energy supply effects).

For the Brayton Point permit, Region 1 attempted to generate a complete monetary benefits estimate (addressing both "use" and "non-use" values) for its BTA determination. EPA hired expert contractors to

assist in that work, at considerable expense, and found that the effort was extremely difficult, time-consuming and produced estimates that proved to be highly controversial. That appears to have been the only instance where a permitting agency attempted to generate a complete monetary benefits estimate to support a BTA determination. Region 1 found that the costs were not wholly disproportionate to the monetized benefits.

For the Merrimack plant, its most recent BTA determination, Region 1 evaluated a variety of alternatives in terms of their ability to reduce entrainment and impingement mortality, their technological and economic feasibility, operational concerns, cost, secondary environmental effects, energy considerations, among other factors. The agency "screened out" some of the options and evaluated others in greater detail, including comparing their costs and benefits based on monetized estimates of one-time and recurring costs to the company as well as "social costs" (i.e., costs to society). Benefits were assessed in terms of the number of organisms saved and a qualitative assessment of the public value of the organisms saved and the aquatic habitat improved. Region 1 considered a comparison of the social costs and social benefits in determining BTA for the plant, assessing the benefit of BTA options through quantitative non-monetary measures and qualitative evaluations without attempting to generate a complete monetized estimate of benefits. Ultimately, Region 1 concluded that installing closed-cycle cooling using wet or hybrid wet/dry mechanical draft cooling cells and operating in a closed-cycle cooling mode from April through August (i.e., during the entrainment season) would achieve the greatest reduction in entrainment of the available alternatives that were evaluated in detail for Merrimack, and is affordable and technologically feasible.

FACTORS

EASE OF EXECUTION: **EASY**. EPA Region 1 has a technology-driven approach. It has taken the Region some time to develop each permit, but Region 1 has made more BTA determinations in recent years than just about any state.

TECHNOLOGY EVALUATION PROCESS: Region 1's technology-based approach is consistent with the intent of the Clean Water Act.

BIOLOGY EVALUATION PROCESS: Region 1 considers each plant's environmental impact on all affected species, and considers cumulative impacts of other cooling water intakes in the same area.

RECONSIDERATION OF PAST BTA DETERMINATIONS: No information on historic BTA determinations.

WRITTEN POLICIES AND PROCEDURES: Region 1 does not have written procedures, as it is a branch of EPA, which has not issued legislation or guidance for existing power plants. The Region makes case-by-case determination, but follows a consistent regulatory approach in doing so.

GATHERING DATA: Region 1 uses its Clean Water Act section 308 authority to request information needed to make its BTA determinations. Unlike some states (e.g., New York, New Jersey, Connecticut) that use the NPDES permits themselves as a vehicle to require the submittal of studies to be used in BTA determinations, Region 1 requests information via section 308 letters and holds off on issuing the permit until all information is in and the BTA determination made.

ILLINOIS

OVERALL ENVIRONMENTAL PROTECTION:
VERY LOW

The Illinois Environmental Protection Agency avoids making BTA determinations.[65] Many of the once-through cooling systems in Illinois were built 40 or 50 years ago and have not been reassessed since. At some plants, Illinois EPA has delayed biological sampling and economic analysis for more than a decade. On the positive side, in recent years, Illinois EPA has taken a more critical view of thermal pollution and pushed power plants to reuse cooling water in order to reduce their waste heat discharges. But on balance, Illinois' approach to cooling systems is replete with practices that other states should avoid.

OVERVIEW OF ILLINOIS:

With its strong industrial base and coal mining history, Illinois is home to many older thermal power plants located on rivers, lakes and along the shores of Lake Michigan. Consequently, Illinois EPA has regulatory oversight of numerous antiquated once-through cooling systems.

It is unclear whether Illinois has a written cooling water intake policy. But judging by the state's permitting practices, if such a policy exists it is likely several decades out of date. Illinois EPA approved the use of once-through cooling systems at many power plants in the 1970s and 1980s. In many cases, the state has never revisited these decisions. And in recent years,

Illinois EPA seems to have deliberately stalled its data gathering efforts at some power plants. This means that, once EPA publishes its final rule, Illinois EPA will suddenly be faced with a backlog of under-regulated cooling water intakes that will require significant analysis. It does not appear that Illinois EPA is ready for the task.

On the other hand, Illinois EPA has begun setting more stringent heat limits in some NPDES permits in order to meet thermal water quality standards established under the Clean Water Act. At some plants, this has led to the use of closed-cycle cooling on a partial or seasonal basis. So by trying to reduce waste heat pollution, Illinois EPA has driven partial reuse of cooling water at some plants. This decreases the total amount of water withdrawn from rivers and lakes, and therefore reduces fish kills at cooling water intakes too.

Illinois EPA's renewed emphasis on heat limits could help the agency streamline its BTA process for reducing impingement and entrainment mortality. Closed-cycle cooling protects fish and other organisms from being sucked into an industrial cooling system at one end of the pipe while greatly reducing waste heat discharges at the other end. By combining thermal discharge analysis with impingement and entrainment reduction analysis, Illinois could prioritize cooling system technologies that provide the greatest cumulative environmental benefits. For example, wedgewire screens will probably reduce impingement and entrainment compared to the screens currently in use at most power plants, but these improved screens do nothing to reduce waste heat discharge. In contrast, variable speed pumps (for peaking units) and closed-cycle cooling advance both policy objectives at once.

FACTORS

EASE OF EXECUTION: **DOING NOTHING WAS EASY, BUT THOSE DAYS ARE OVER.** Past inaction suggests that Illinois EPA may have difficulty meeting its obligations under EPA's forthcoming regulations in a timely manner. But with its emphasis on reducing thermal pollution, the agency could streamline its response to EPA's new rules by adopting a goal of ending the use of once-through cooling at large power plants. This would protect Illinois' ecosystems from waste heat pollution while also greatly reducing impingement and entrainment—accomplishing two important policy goals at once.

TECHNOLOGY EVALUATION PROCESS: By delaying BTA decisions or not revisiting decisions that were made 40 years ago, Illinois EPA appears to avoid implementing Section 316(b) of the Clean Water Act entirely (although it does require cooling towers where necessary to address thermal pollution concerns under Section 316(a) of the Act). This is not a feasible approach anymore because EPA's new cooling water regulations will require Illinois EPA to finally make BTA determinations.

BIOLOGY EVALUATION PROCESS: There is not enough information available to determine how Illinois EPA approaches impingement and entrainment mortality. There is some evidence that, after years of inaction, Illinois EPA is now increasing enforcement of thermal water quality standards that are meant to protect aquatic organisms.

RECONSIDERATION OF PAST BTA DETERMINATIONS: Illinois appears to avoid re-examining the requirements applied to individual once-through cooling systems even if the cooling system's environmental impact has not been looked at for more than 40 years. For example, in the past decade, Illinois EPA has reissued NPDES permits without scrutinizing whether continued use of once-through cooling is still appropriate at the Wood River Power Plant (once-through cooling approved in 1985); Newton Power Station (1981); and the Coffeen Power Station (1982).

WRITTEN POLICIES AND PROCEDURES: Unclear whether Illinois has a formal policy.

GATHERING DATA: Illinois EPA appears to deliberately stall the data collection process in order to defer changes to antiquated once-through cooling water systems. For example, the Waukegan power plant on Lake Michigan operated a decades-old once-through cooling system on an expired NPDES permit for 7 years before Illinois EPA finally issued the plant a new draft NPDES permit in 2012. But the new permit does not contain a BTA determination for Waukegan, it merely requires the plant's owners to submit some of the data that Illinois EPA will need in order to make a BTA determination in the future. Illinois EPA could have requested and obtained that data much earlier and included a BTA determination in the new permit, as the Clean Water Act requires. But it appears that, for 12 years, Illinois EPA made no effort whatsoever to obtain this data.[66]

LOUISIANA

OVERALL ENVIRONMENTAL PROTECTION:
VERY LOW

The Louisiana Department of Environmental Quality is tasked with protecting the historic Lower Mississippi River and the Mississippi River Delta. Home to some of the most biologically productive estuaries in the United States, the Lower Mississippi and Delta serve as breeding grounds for enormous populations of fish and shellfish. LDEQ is outspoken in its belief that there is no need to retrofit cooling water intakes to reduce fish kills unless there is proof that the fish kills have a significant adverse environmental impact on the ecosystem as a whole. But as other regulators have noted, isolating the impact of just one factor affecting the health of fish populations and the ecological structure of an enormous, complex and dynamic system like the Lower Mississippi River is difficult, if not impossible. Even though some plants in the Delta kill more than 100 million fish and other organisms every year, Louisiana has never found a significant adverse environmental impact that would justify a move to closed-cycle cooling at any power plant.

OVERVIEW OF LOUISIANA:
Many of Louisiana's power plants are located along the Mississippi River, while others are located on the channels, bayous and canals of the Mississippi River Delta. The Delta is a coastal estuary, one of the most productive aquatic ecosystem types on the planet. Both the Mississippi River and the Delta are home to many endangered species of sea turtles, fish and other aquatic organisms.

Looking at the Mississippi River as a whole, LDEQ takes the position that fish kills at power plants have no significant environmental impact discernable at the level of the entire regional ecosystem. In expressing this view to EPA, LDEQ pointed primarily to the example of power plants built along the main stem of the Mississippi that kill relatively few fish. Many of these plants draw water from intakes located 30 or 40 feet deep and far out in the fastest moving parts of the river channel, where fish populations are less dense than along the shore. Impingement rates at these plants are low compared to other plants along the Mississippi, often in the range of 1 million organisms per year. But LDEQ does not require most of the plants along the Mississippi to monitor entrainment, so their total fish kills are not adequately characterized. And the mainstem of the Mississippi River is home to a number of endangered species that are known to live in the faster-moving waters near these intakes, including both sturgeon and American paddlefish.

Further, LDEQ's belief that power plants don't harm fish populations seems consistent whether a plant impinges 1 million fish or 100 million fish. The Teche power plant is a relatively small plant with a daily cooling water intake of less than 300 MGD, less than half the size of some of the larger plants along the main stem of the Mississippi. But Teche is located in the Mississippi Delta on the Charenton canal, just north of national and state wildlife refuges. In this biologically rich area, the plant kills more than one hundred million young fish annually. Although LDEQ has not made a final determination yet about the appropriate cooling water intake system for Teche, it is notable that LDEQ has studied fish mortality at similar power plants since the early 1970s but has never determined that a move to closed-cycle cooling system is warranted.

FACTORS

EASE OF EXECUTION: **MODERATE**. Procedurally, Louisiana appears to have a well-defined and consistent BTA determination process. In recent years, LDEQ has required numerous power plants to submit most of the environmental and technical information the agency needs in order to make final BTA determinations. This otherwise well-functioning process is short-circuited by the LDEQ's commitment to avoiding environmentally protective actions until it has evidence of population-level or ecosystem-wide environmental harm. Thus, LDEQ readily approves analytical reports from power plants that provide only a perfunctory analysis of closed-cycle cooling technology before summarily rejecting this option as unnecessary and overly expensive. Despite this significant flaw, LDEQ has amassed much of the information that it would need to make strong BTA determinations—if the agency so desired.

TECHNOLOGY EVALUATION PROCESS: LDEQ's technology evaluation process appears relatively weak, perhaps because analytical outcomes are largely pre-determined by the agency's population-level and ecosystem-wide approach to defining environmental harm. In any case, LDEQ does not require thorough evaluation of closed-cycle cooling systems. It has accepted numerous studies from applicants that include only perfunctory analysis of a closed-cycle cooling system after which the applicant rejects the technology. Often, that rejection is based on the "cost-

cost" test announced in EPA's suspended regulations for existing cooling water intakes (although the rules are suspended, LDEQ seems to use them as guidance for permittees). Under the "cost-cost" test, a regulator can reject the use of a more protective technology, such as closed-cycle cooling, if the costs of installing the technology at a power plant are significantly greater than the costs considered by EPA when it formulated its regulations.

In addition to its willingness to accept technological analyses that contain only perfunctory examination of the most protective technologies, LDEQ can be slow to act on cooling water intakes. For example, at the Teche plant mentioned above, LDEQ accepted a "316(b) submittal" from the power plant before issuing a permit in 2009 that included a great deal of biological and technical data on the cooling water intake structure, the aquatic life in the area and the rates of impingement and entrainment. But LDEQ then gave the plant four more years to "assess how structural or operational actions" could reduce Adverse Environmental Impact. The full assessment, including the review of structural and operational actions, could have been completed in a single permit term. Indeed, LDEQ has directed another facility, the Dow Chemical Plant, to conduct such a start-to-finish review in a single permit term.

BIOLOGY EVALUATION PROCESS: As noted above, LDEQ's treatment of the ecological significance of fish kills is a critical weakness in its regulatory system because it effectively excuses fish kills at every power plant in the state. Weak entrainment monitoring rules are another flaw in LDEQ's regulatory approach. LDEQ has suggested that power plants should follow a provision of a suspended EPA regulation that allows plants withdrawing less than 5 percent of a river's annual mean flow for cooling purposes to avoid entrainment monitoring and controls. Many LDEQ plants are on very large waterbodies like the Mississippi River. Even large plants taking in more than 500 million gallons of cooling water daily do not withdraw 5 percent of the Mississippi's flow. Therefore, many power plants in Louisiana do not monitor or control entrainment, and the environmental impact of entrainment is generally overlooked.

RECONSIDERATION OF PAST BTA DETERMINATIONS: Unlike some states that have not revisited the cooling water intakes at power plants since they were built, LDEQ addresses the state of a power plant's cooling water intakes at every NPDES permit renewal. That said, in the permits reviewed for this report, LDEQ simply accepted the status quo and asked each power plant to provide more environmental or technical information about its cooling system in the future. But Louisiana does include a provision in every NPDES permit informing the permittee that their permit can be reopened to add more stringent cooling water intake controls if required by a change in federal law and regulation.

WRITTEN POLICIES AND PROCEDURES: Louisiana has a well-developed process for gathering information that suggests internal policies and protocols are well-established. But the substance of those policies is deeply problematic. In public comments sent to EPA relating to the most recent draft federal regulations for cooling water intakes, Louisiana was a leading advocate for the view that fish kills are only significant if they have a discernable and significant impact on the ecosystem as a whole, such as a decrease in the entire population of a species in the Mississippi River. As noted earlier in this report, this unworkable approach to environmental regulation has been rejected by other states and challenged by EPA.

GATHERING DATA: Procedurally, LDEQ is quite strong. The agency asks all permittees to provide information about the nature of the ecosystem affected by a power plant and the numbers of fish and other organisms killed by entrainment and impingement. LDEQ also evaluates the data gathering plans submitted by power plants to ensure that they are adequate, and sends formal letters of approval or disapproval. LDEQ also creates an internal record confirming that, if the permittee follows the plan, they will have sufficient data to make a BTA determination.

MARYLAND

OVERALL ENVIRONMENTAL PROTECTION:
VERY LOW

In the late 1970s and early 1980s, Maryland approved the use of once-through cooling water intakes at many power plants. The state has never reconsidered these decisions. Since then, the health of the Chesapeake Bay has declined steadily. Reconsideration might be fruitless, however, because Maryland's policy is to take no action to control impingement unless the costs of saving fish justify the monetized benefits. But the state greatly underestimates those benefits by valuing commercially-harvested fish at a small fraction of their market value and valuing all other species of fish at a small fraction of the non-market values that have been revealed through econometric studies. Also, Maryland does not act to reduce entrainment at a power plant unless the plant owner's research (or the state's research) proves that the fish kills have a significant ecosystem-wide or population wide impact. The predictable consequence of these rules is that Maryland accepts the existing once-through cooling system at most power plants as the "best" technology available. The state has only once required a plant to take protective physical or operational measures, and that consisted only of installing a barrier net to reduce impingement (with no effect on entrainment).

OVERVIEW OF MARYLAND:
Maryland's Department of the Environment (MDE) regulates at least ten large existing power plants with cooling water intakes that will be subject to EPA's forthcoming rules. Most are located on the Chesapeake Bay or a tributary. MDE receives analytical support and guidance from the Maryland Power Plant Research Program, a small agency created in the 1970s, following the public outcry over the opening of the Calvert Cliffs nuclear plant. The Power Plant Research Program (PPRP) advises the state regarding the environmental and economic considerations associated with power generation, including cooling water withdrawals. MDE remains responsible for issuing and enforcing NPDES permits.

Despite having two agencies involved in regulating cooling water intakes, Maryland's NPDES permitting process generates poor environmental outcomes. Forty years ago, based on a lack of evidence of ecological impacts, Maryland allowed the use of once-through cooling at many of the state's largest power plants. MDE has never reconsidered these decisions. And Maryland has issued at least six permits in the past five years that lack a final BTA determination.

In the late 1970s, Maryland developed and implemented regulations for cooling water intakes that are quite detailed and extensive in comparison to those of many other states. The regulatory framework is based on the state's determination of the ecosystem-wide or population-level effects of impingement and entrainment. As Maryland explains, "the direct effect of the cooling water intake (i.e., the number of fish impinged or entrained) is not the major focus of our regulations; it is the consequence of that effect to the biological entity of concern, whether at the species or the ecosystem level, that establishes what actions the state will take."[67]

FACTORS

EASE OF EXECUTION: **DIFFICULT**. Maryland has created an illegal and overly-complicated biological analysis process that requires state officials to determine that impingement and entrainment have ecosystem-wide impacts before any action will be taken to reduce fish kills. Because ecosystem-wide biological analysis is complex and uncertain, it is also contentious. At the sole power plant at which Maryland found a significant ecosystem-wide impact (Chalk Point), the finding led to a protracted dispute with the permittee and extensive negotiations followed by a compromise on environmentally protective measures.

TECHNOLOGY EVALUATION PROCESS: When evaluating more protective impingement technologies, Maryland uses a deeply skewed cost-benefit analysis process that virtually assures no change. The state estimates the number of fish killed by impingement at a power plant, places a prescribed dollar value on each, and then (arbitrarily) adjusts this value downwards by 25 percent if the species in question is a forage fish. The dollar values for fish were set by regulation in Maryland in the late 1970s and have not been adjusted since then. They clearly do not reflect current public values for fish, as reflected in the environmental economics literature and confirmed by recent EPA studies. For example, Maryland values a 12-inch largemouth bass at $2.00, although sport fishermen are willing to spend many times this amount to catch one. The iconic diamond-back terrapin turtle—a species protected from commercial harvest in Maryland because of its continued decline—is valued at $1.00 per pound. Similarly, Maryland places the value of a full-grown American eel at 30 cents, even while the U.S. Fish & Wildlife Service considers listing the species as endangered. The values for commercial fish species are no more realistic. Maryland's regula-

tions mandate values of less than $1 per pound for a number of popular and expensive saltwater species: bonito, cod, hake, kingfish, mackerel, mullet, porgy (scup) and blackfish (tautog). The state's valuations are far below the commercial value of these species.

BIOLOGY EVALUATION PROCESS: The fatal flaw in Maryland's system for regulating cooling water intakes is the state's insistence on waiting for evidence that a power plant's fish kills have species-wide or ecological importance before it will act. Maryland will not act to reduce entrainment of small fish, larvae and eggs, unless it first determines that the entrainment losses caused by a power plant have measurable and significant species level or ecosystem level effects outside of a defined "mixing zone." Power plants are also asked to determine whether their intake affects breeding habitat (a "Spawning or Nursery Area of Consequence") for representative species of fish.

This focus on species or ecosystem-level harms is a massive hurdle blocking the Clean Water Act's goal of minimizing adverse environmental impacts. Even under the best conditions, ecosystem or population level impacts are extremely difficult to measure or model. And the cumulative impact of other environmental stressors must be taken into account when looking at the significance of fish kills at one plant in the Chesapeake Bay, a large waterbody that supports numerous power plants with once-through cooling systems. But in Maryland, there is no formal process for cumulative impacts analysis in evaluating the significance of impingement and entrainment. The primary consequence of Maryland's ecosystem-wide analysis process is to deeply entrench the use of once-through cooling systems that kill tens of millions of fish annually.

The secondary consequence of relying on these complex and contentious biological metrics is that, in the rare case where Maryland determines that more protective technology is appropriate, an extensive fight with the permittee is assured. At Chalk Point, in the late 1980s, the power plant owner determined that 4 percent of the bay anchovies in the entire estuary were being sucked into the plant. Maryland's Power Plant Research Program analyzed the same data and concluded that the true figure ranged from 14 percent to 51 percent of the population, most probably 20 percent to 30 percent annually. Although Maryland considered such extensive fish kills to be an adverse environmental impact, the factual and technical dispute led to a negotiation process that, two years later, resulted in a compromise NPDES permit calling for the use of barrier nets and habitat restoration payments to compensate for the continued losses of fish.

RECONSIDERATION OF PAST BTA DETERMINATIONS: Maryland approved the cooling water intakes at its major power plants in the 1970s and 1980s and has not revisited these decisions since then. Further, Maryland's regulations exempt facilities withdrawing less than 10 MGD and less than 20 percent of stream flow from analysis entirely, and has asked EPA to presume that any facility withdrawing less than 125 MGD has no adverse environmental impact unless already available information shows otherwise.

WRITTEN POLICIES AND PROCEDURES: Thanks to the Maryland Power Plant Research Program, the State of Maryland has extensive and long-standing written guidance for regulating cooling water withdrawals. The reason for Maryland's lack of progress in reducing fish kills and restoring the health of the Chesapeake is not procedural; it is substantive. The extensive and long-standing policies that Maryland relies on are deeply flawed because they impose high hurdles in the way of improved cooling water technologies such as closed cycle cooling and entrench the use of antiquated once-through cooling systems.

GATHERING DATA: Maryland's data gathering procedures are not the problem. The MDE and the Power Plant Research Program gather extensive data from permittees, conduct their own studies and are willing to disagree with the biological findings submitted by a power plant owner—as they did at Chalk Point.

NEW JERSEY

OVERALL ENVIRONMENTAL PROTECTION:
MODERATE

Although many of New Jersey's large power plants are located on very similar bodies of water, permitting outcomes vary widely. The New Jersey Department of Environmental Protection issued a draft NJPDES permit to the Oyster Creek nuclear plant requiring a conversion to closed-cycle cooling. But at other plants, NJDEP has acquiesced to the use of significantly less protective technologies.

OVERVIEW OF NEW JERSEY:

The challenges that New Jersey has faced in setting cooling water intake controls exemplify the problems all states face in making case-by-case decisions in the absence of a clear national standard. The process is resource intensive, inconsistent and lengthy.

The most evident inconsistency is in NJDEP's approach to the costs and benefits of different technologies. In the absence of better national standards, NJDEP would benefit from adopting a clear, consistent and straightforward standard of its own for cooling systems.

Despite its problems, NJDEP's permitting reflects two best practices that other states should strongly consider adopting: (1) using outside technical expertise for biological analysis where needed; and (2) measuring adverse environmental impact in terms of impingement and entrainment of individual organisms, rather than seeking population level effects. Other states who adopt these practices may find that they considerably reduce the time and resources invested in writing environmental permits for cooling water intakes and may reach more environmentally protective outcomes.

Power companies hire biologists and other technical consultants to conduct complex impingement and entrainment studies (and technology analyses). Regulators can be inundated with technical material as part of a deliberate effort on the part of power companies to delay the expense of conducting environmentally protective retrofits. In New Jersey, the Salem NPDES permit renewal application comprised 36 volumes, supported by 137 volumes of technical and reference materials. It took NJDEP seven years to review and act upon this submission. Invariably, power companies use this mass of data to argue that the ecological benefits to society of moving to a closed-cycle cooling system are not sufficient to justify the expense.

To manage this morass, NJDEP retains technical consultants to help the department evaluate the merits of applicant's studies. Documents provided by NJDEP do not make clear whether NJDEP pays for this external expert review or whether this cost is passed on to power plants.

The depth of NJDEP's reconsideration of cooling system impacts seems to vary greatly according to plant size. Although the policy is not explicit, NJDEP appears to focus considerably more attention and effort on BTA determinations for the large cooling water intakes at baseload power plants. We have not reviewed sufficient information to determine whether this is a sensible strategy, or whether it results in NJDEP missing the opportunity to make reasonably inexpensive and quick changes at smaller power plants.

NJDEP has also rejected faulty biological arguments advanced by permittees. In one example, PSEG, the owners of the Salem power plant, argued that the plant's adverse environmental impact could only be measured at the population level. NJDEP disagreed. In commenting on federal regulations, NJDEP has explained the flaws of the "population-level" approach to EPA: "State agencies and permitting authorities could engage in a debate for years as to the population measure of a given fish species, let alone many fish species. The results of biological population studies and modeling can be very subjective because it is difficult to identify, measure and attribute the impact of each of the many variables…affecting populations of each of the impacted species."[68] To avoid years of fish kills while an ineffective policy debate drags on, NJDEP adopted a simpler position that is endorsed by EPA and is consistent with the meaning and intent of the Clean Water Act — New Jersey considers the death of any fish at or through a cooling water intake to be an "adverse impact" which must be minimized through available technologies.

NJDEP's decisions lack consistency over time. For example, while reviewing the Oyster Creek nuclear plant's cooling system in 1989, NJDEP rejected the idea of making any changes to the existing once-through cooling system that impinged millions and entrained billions of organisms each year. NJDEP even rejected the use of screens, the cheapest and least effective technology, on the grounds that the costs of reducing fish kills would far outweigh the benefits. In 2010, NJDEP issued a draft permit for Oyster Creek

stating that, in the Department's best professional judgment, closed-cycle cooling was the best technology available. In so doing, NJDEP overruled technical objections raised by the permittee and, while NJDEP took costs into account as it had in 1989, this time they were not the critical factor in its decision.

NJDEP's analysis of the costs and benefits of reducing fish kills has varied widely over time and across plants. In 2000, when writing a NPDES permit for the Salem power plant, NJDEP announced that its policy is to choose the most environmentally protective technology option so long as the costs and benefits of the technology are not wholly disproportionate. This "wholly disproportionate" standard, originally introduced by EPA in the 1970s, responds to a significant and systemic bias in most environmental economic analyses: the costs of installing a particular technology are well understood and are accurately valued, but the benefits of protecting fish and ecosystems translate poorly into dollar terms and are greatly undervalued.

But despite having adopted a wholly disproportionate standard, NJDEP rejected closed-cycle cooling in favor of traveling screens that kill far more fish at both the Mercer and Hudson power plants. In rejecting closed-cycle cooling at these plants, NJDEP relied in part on deeply flawed cost-benefit studies, provided by the power plant owners, that zeroed-out the value of all non-commercial species of fish. In part, NJDEP also based its decision on the same minor technical objections that NJDEP would later overrule at Oyster Creek (including concern about the aesthetics of closed-cycle cooling). The 2010 draft NPDES permit for the Oyster Creek plant, calling for the use of closed-cycle cooling, was based on an analytical process that appears more consistent with the "wholly disproportionate" standard.

NJDEP also treats low capacity power plants quite differently from the large plants discussed above. While New Jersey conducts BTA determinations at "peaking" power stations (plants operating at a small fraction of their capacity), NJDEP seems quite ready to accept the status quo of once-through cooling at these plants. For example, in renewing the Sewaren power plant's NPDES permit in 2011, NJDEP approved the existing once-through cooling system without any modifications as the best technology available on the basis that the facility has historically operated at less than 15 percent capacity, and has not exceeded 4 percent capacity since 2006. NJDEP also approved continued use of once-through cooling at the Kearny power plant in 2010 based on its less than 5 percent capacity factor. NJDEP has taken similar positions at the Deepwater and BL England power plants. NJDEP considered technology options ranging from improved screens to closed-cycle cooling at these facilities, but then decided that improvement of the once-through cooling system is not warranted in light of the limited use of these plants.

There is not enough information available to fully assess this permitting strategy. While some low capacity plants only run their cooling system when the electricity turbines are operating, others operate their intake pumps at full flow at all times. Such plants would see a tremendous reduction in impingement and entrainment from the use of variable speed pumps that reduce the cooling water flow to match the plant's need. The permit documents provided by NJDEP do not make clear into which category the Sewaren and Kearny plants fall.

FACTORS

EASE OF EXECUTION: **DIFFICULT**. Even without formalized cost-benefit analysis and population-level biological analysis, power plants and NJDEP staff invest considerable time and resources in each permitting decision.

TECHNOLOGY EVALUATION PROCESS: Although most of its thermal power plants are located in similar coastal estuaries and large rivers, in recent years New Jersey has approved every technology from closed-cycle cooling to once-through cooling as the "best" technology available for these facilities. The range in NJDEP's conclusions and methods is hard to understand—not only across plants, but even at a single plant.

BIOLOGY EVALUATION PROCESS: NJDEP's permitting experience highlights the significant drawback of basing decisions about the best technology available for a cooling water system on intensive, case-by-case biological analysis, rather than a straightforward engineering and economic analysis of whether the best technologies, such as closed-cycle cooling, are feasible and affordable.

RECONSIDERATION OF PAST BTA DETERMINATIONS: With some exceptions, NJDEP generally includes a BTA determination based on whatever data is on hand in its NPDES permits, and generally revisits the determination with each permit cycle. In many cases, that information is carried forward from an earlier permit. NJDEP has re-evaluated the cooling water systems at many of New Jersey's oldest plants in the past decade. At present, however, New Jersey

is delaying some determinations until EPA's new rules are finalized.

WRITTEN POLICIES AND PROCEDURES: When asked, NJDEP did not provide a guidance document or Standard Operating Procedure explaining how the department makes BTA determinations. Therefore, it is not clear that there is a single written policy. But there are consistent departmental policy positions referred to in multiple NPDES permits, and BTA determinations tend to take the same format across all permits. Every NPDES permit contains a statement of the facts and reasoning used in deciding upon the best technology available for reducing the adverse environmental impacts of the facility's cooling water intakes.

GATHERING DATA: NJDEP appears to use the NPDES permitting process as its main data gathering tool. That is, if NJDEP lacks biological or technical data related to a power plant, it inserts a special condition in the plant's NPDES permit upon renewal, requiring the plant operator to provide the missing information on a schedule, typically in time for NJDEP to consider the information during the next 5-year permit renewal process. The negative consequence of this data gathering approach is that it may take two or more 5-year permit cycles to make a final BTA determination. It is not clear whether NJDEP has also used letters or other information requests to hasten the data gathering process.

NEW YORK

OVERALL ENVIRONMENTAL PROTECTION:
MODERATE

New York has a statewide BTA policy identifying closed-cycle cooling as BTA, but the policy does not require closed-cycle cooling in all cases. The New York State Department of Environmental Conservation has issued two draft NPDES permits calling for closed-cycle cooling systems, but neither of those permits have been issued in final form, ten and four years, respectively after the drafts were issued.

OVERVIEW OF NEW YORK:
Industrial water users in New York, primarily power plants, withdraw more than 16 billion gallons of water from state waters each day, resulting in the annual impingement and entrainment of 17 billion fish of all life stages. To address these impacts, in 2011, the Commissioner of the New York State Department of Environmental Conservation (DEC) issued Commissioner's Policy CP#52, entitled "Best Technology Available (BTA) for Cooling Water Intake Structures"[69] The Policy applies to all existing industrial facilities designed to withdraw at least twenty million gallons per day from the waters of New York State. It outlines the reductions in impingement mortality and entrainment required to minimize the adverse environmental impact caused by cooling water intake structures. Through the policy, the Department identified closed-cycle cooling or the equivalent as the performance goal for BTA to minimize adverse environmental impacts at existing and repowered power plants. DEC explained:

> The demonstrated technology that achieves the greatest reduction in non-contact cooling water use is closed-cycle cooling … Given the effectiveness of closed-cycle cooling at reducing adverse environmental impact caused by a CWIS, the biological significance of New York's surface waterbodies and their importance for commercial and recreational uses, *particularly in the marine and coastal district, the tidal reach of the Hudson River and the Great Lakes,* this policy establishes closed-cycle cooling as the performance goal for all new and repowered industrial facilities in New York. The performance goal for all existing industrial facilities in New York is closed-cycle cooling or the equivalent.[70]

In a statement accompanying release of the draft BTA policy in 2010, the Commissioner stated: "With this policy, New York is saying that closed cycle cooling is the best technology available and must be implemented to protect the environment."[71] The Commissioner added that the Policy will "add significant protections for New York's vital fisheries by slashing water intake at certain power plants."[72]

Existing power plants designed to use less than twenty million gallons per day are not subject to the Policy and will instead have their BTA requirements determined by the Department on a case-by-case basis. The Policy also does not apply to plants for which a BTA determination has been issued prior to issuance of the Policy and which are in compliance with an existing compliance schedule of BTA implementation and verification monitoring, unless the results of verification monitoring demonstrate the necessity of more stringent BTA requirements. Following the completion of the verification monitoring program, DEC will conduct a full technical review

for these facilities when a permit renewal or modification application is submitted. In addition, for certain plants that are operated at less than 15 percent of their electric generating capacity the Department may determine entrainment goals on a site-specific basis.

Plants seeking to meet the equivalent performance goal set by the Policy must propose a suite of technologies and operational measures to the Department for consideration as BTA, including reductions in cooling water capacity and fish protective outages. DEC makes BTA determinations with staff from its Division of Environmental Permits, Division of Fish, Wildlife and Marine Resources and Division of Water. While DEC does not typically hire outside consultants to assist in making its BTA determinations, it has on at least one occasion received technical assistance from a consultant retained by the U.S. EPA.

New York's policy is implemented when a permittee seeks to renew or modify an existing NPDES permit or when a NPDES permit is modified by the Department. Unlike California's policy, New York's does not have a schedule of compliance dates. After selecting the best technology available for a plant, the Department will consider the cost of the feasible technologies and will determine whether or not the costs of the technologies are wholly disproportionate to the environmental benefits to be gained from the technology. The Department does not undertake formal, monetized cost-benefit analyses. Instead, DEC selects a feasible technology whose costs are not wholly disproportionate to the environmental benefits to be gained, assessed in a qualitative and/or quantitative fashion. In applying this "wholly disproportionate" test, DEC does not include reductions in thermal discharges as a benefit to be gained, although such benefits clearly exist.

If a nuclear plant demonstrates to Department staff that compliance with the performance goals of the Policy would result in a conflict with a safety requirement established by the Nuclear Regulatory Commission (NRC), with appropriate documentation or other substantiation from the NRC, the Department will make a site-specific determination of best technology available for minimizing adverse environmental impact that would not result in a conflict with the NRC's safety requirements. This provision is identical to a provision in California's policy.

Unlike other states (e.g., New Jersey and Connecticut) that have stopped making BTA determinations while awaiting EPA's regulations, DEC is proceeding with permitting decisions for power plants, albeit at a very slow pace. DEC conducts environmental impact reviews of any permitting decision requiring closed-cycle cooling.

In addition, DEC's regulations allow draft NPDES permits to be adjudicated by the permittees or intervenors, such as environmental groups. These adjudications are presided over by a DEC administrative law judge in a trial-like hearing, with several opportunities to appeal interim rulings to the DEC Commissioner. Such appeals can take years to resolve, stretching the adjudicatory process over an extended period of time and often significantly delaying final permitting determinations.

DEC has made two BTA determinations in which it has found closed-cycle cooling to be the best technology available, both of which came before the Policy was issued in 2011—first, in 2003, for the Indian Point nuclear plant on the Hudson River in Buchanan, and, second, in 2009, for the E.F. Barrett plant in Island Park on the South Shore Estuary of Long Island. The draft permit for Indian Point has been in the adjudication process since 2003 and the draft permit for Barrett has been under environmental review since 2010; a draft environmental impact statement for Barrett is expected soon. Given that NPDES permits are supposed to be of no more than five-year's duration, these delays are clearly contrary to the intent of the Clean Water Act.

DEC has made few BTA determinations since the Policy was issued in 2011. For the Port Jefferson plant on the North Shore of Long Island, a peaking plant which may be subject to the fifteen percent capacity factor exception, DEC made a BTA determination that required, in lieu of closed-cycle cooling, a 95 percent reduction in impingement mortality, 80 percent reduction in entrainment mortality a 15 percent capacity factor limitation (i.e., the plant may not operate more than 15 percent of the time), installation of variable speed pumps to reduce water withdrawals in reasonably short time frame, aggressive pump shutdown procedures when the plant goes off-line and the other is shut down as soon as the plant cools sufficiently, and installation of modern Ristroph screens with fish return to reduce impingement. Very recently, DEC made a BTA determination for the Bowline (Units 1 & 2) plant on the Hudson River in Haverstraw, issuing a permit that limits plant operations and water withdrawals to less than 15 percent of capacity.

FACTORS

EASE OF EXECUTION: **DIFFICULT**. While the adoption of a statewide policy should be expected to streamline permitting, DEC continues to make its BTA determinations on what amounts to a case-by-case basis, despite the policy. These determinations can take many years to be made in draft form and much longer to become final.

TECHNOLOGY EVALUATION PROCESS: To its credit, DEC makes technology-based determinations based on the most effective technology that is feasible and passes a "wholly disproportionate" test.

BIOLOGY EVALUATION PROCESS: DEC considers impacts on all species and does not uncritically accept companies' claims of impingement or entrainment survival.

RECONSIDERATION OF PAST BTA DETERMINATIONS: DEC's policy exempts all plants at which a final BTA determination has ever been made from any further review (unless verification monitoring turns up a problem). But, practically speaking, most of New York's power plants are not yet subject to a final BTA Determination and DEC's policy requires reconsideration of BTA at all of these plants during the next technical review of the relevant permit.

WRITTEN POLICIES AND PROCEDURES: DEC has adopted a unified statewide policy.

GATHERING DATA: DEC requires plants to prepare a series of biological and technological studies to support its BTA determinations.

OHIO

OVERALL ENVIRONMENTAL PROTECTION: **LOW**

The Ohio Environmental Protection Agency does little to control the adverse impacts of cooling water systems. Rejecting the precautionary principle, the agency generally will not raise standards for a cooling water system unless it has clear evidence of increasing population or ecosystem level harms before it. Such evidence is very hard to establish, which is why Congress rejected this water-quality based permitting approach in the 1970s. But Ohio EPA generally accepts existing once-through cooling systems, without modification, as the "best technology available" for older power plants. At the Bayshore Power plant, the only facility where Ohio EPA is demanding change, the agency pulled its punches by targeting reductions of 80 percent for impingement and 60 percent for entrainment mortality—far laxer than the 90 percent or better reductions achievable with closed-cycle cooling. Further, Ohio EPA is allowing the plant operator to attempt compliance through use of technology that both agency staff and external advisers believe will fail to reduce entrainment adequately.

OVERVIEW OF OHIO:

To its credit, Ohio EPA has established clear BTA policies that give staff considerable guidance. The agency is generally well resourced and, when faced with the need for complex biological and engineering analysis that exceeded its capability at the Bayshore power plant, Ohio EPA called on US EPA to provide funding for external consultants who could bolster staff efforts. Despite these advantages, Ohio EPA consistently issues permits that fall far short of the Clean Water Act requirement to minimize the adverse environmental impact of cooling water intakes.

The Bayshore power plant was the most glaring example of Ohio EPA's questionable permitting practices. Bayshore is a coal burning power plant located at the confluence of the Maumee River and Lake Erie—one of the most remarkably productive estuaries in the Great Lakes. Until three of the plant's four units shut down in September 2012, the Bayshore plant's cooling water intake structure was among the most deadly in American freshwaters: it entrained and impinged billions of eggs, larvae and fish every year. Just a few years ago, Ohio EPA admitted that the plant likely impinged and entrained more fish than all of Ohio's other cooling water intakes combined. Even with just one unit in operation, Bayshore likely kills more fish than many other power plants.

In 2010, Ohio EPA issued a NPDES permit giving Bayshore until 2013 to reduce impingement by 80 percent and entrainment by 60 percent. The permit contemplated that, to achieve these targets, Bayshore would pilot test a system of louvers between 2010 and 2012, before installing a full-scale louver system. In issuing the permit, Ohio EPA effectively overruled the advice of environmental groups and the conclusions of its external consultants and its own staff, who pointed out that:

- The 80 percent impingement and 60 percent entrainment reduction targets were the low end of a range contemplated by EPA; 90 percent reductions in both categories are feasible at Bayshore;

- The pilot-testing program for louvers at Bayshore is unlikely to generate enough data to determine whether the final, full-scale system will meet the 80 percent impingement reduction target;
- In any case, louvers were very unlikely to meet the 60 percent entrainment reduction target;
- Louvers would have provided no reduction in Bayshore's discharge of waste heat pollution (At the time, heat pollution from Bayshore made more than a square mile of Maumee unusable for some recreational activities and likely contributed to the growth of nuisance algae);
- Cooling towers are feasible, affordable and would achieve all of these objectives; and
- The economic benefits of cooling towers at Bayshore amply justify the costs.

Beyond Bayshore, the most evident permitting problem is Ohio EPA's rejection of the clear, technology-based approach to writing permits laid out by Congress in the Clean Water Act, in favor of a more complex and illegal water-quality based permitting approach. At Bayshore and other plants, Ohio EPA seeks to ascertain whether the number of fish killed is "acceptable" in light of the overall health status of the ecosystem that they are a part of. Rather than minimizing adverse impacts in a gradual effort to reach the Clean Water Act's goal of ending water pollution and fully restoring all of America's lakes and rivers, Ohio EPA is content to accept the continued use of existing once-through cooling systems.

Ohio's lax approach to existing once-through cooling systems is particularly problematic in light of EPA's new 316(b) regulations, because in the draft proposed by EPA in 2011, the federal agency carved out a loophole that will allow existing power plants to undergo a complete replacement with all-new equipment and still avoid complying with cooling water intake standards for new plants.[73] Thus, without state action, Ohio's zombie intakes could continue to operate for many more decades.

FACTORS

EASE OF EXECUTION: **EASY**. Because Ohio EPA must gather water quality information for other permitting requirements and rarely requires change to existing cooling systems, regulating cooling water intakes likely adds little burden to its existing NPDES permitting workload. Since all new facilities in Ohio have been built with closed-cycle systems for 40 years, it seems that, with the exception of Bayshore, Ohio EPA is sitting back and waiting for its stock of very old facilities to gradually turn over. While simple, this "strategy" kills billions of aquatic organisms every year.

TECHNOLOGY EVALUATION PROCESS: The Bayshore permitting process suggests that Ohio EPA's technology evaluation process is deeply flawed. Not only has the agency set relatively weak impingement and entrainment standards (80 percent and 60 percent reductions where more than 90 percent is feasible), but the agency has ignored the recommendations of its staff, its external consultants and environmental advocates, who all believe that the permittee's plans will fall short of reaching the standards that Ohio EPA has set. Ohio does not maintain a list of mandatory technologies that must be considered in every BTA determination, and does not have a policy encouraging the use of reclaimed water.

BIOLOGY EVALUATION PROCESS: On the one hand, Ohio EPA has competent biologists on staff and has used outside consultants at Bayshore, where the analytical demands could have been overwhelming. Procedurally, Ohio EPA's biological evaluation process is just fine. But the agency's overwhelming focus on biology is impeding achievement of its environmental goals. Ohio EPA is focused on whether the number of fish killed is "acceptable" in light of the overall health status of the ecosystem that they are a part of. Thus, Ohio treats section 316(b) of the Clean Water Act, a technology-based standard, as if it were a water-quality standard. This is exactly the trap that Congress wanted federal and state regulators to avoid. The result is exactly what Congress feared in 1972: Although Ohio EPA is aware that all of the state's older, once-through cooling systems impinge and entrain fish and discharge massive volumes of waste heat, it does almost nothing to end these water pollution problems and restore the integrity of the state's waters.

RECONSIDERATION OF PAST BTA DETERMINATIONS: As noted above, Ohio EPA has a policy of only requiring improvements to a cooling water system if fish kills are unacceptable, meaning that "maintenance of existing balanced communities or the recovery of perturbed or unbalanced communities are impaired or prohibited; or the magnitude of damage to endangered, commercial, sport and/or ecologically valuable species interferes with an existing or planned use of the source water body."[74] Given the difficulty of reaching agreement on large-scale ecological measures like

these, the outcome is that Ohio EPA rarely reconsiders the use of existing cooling water intakes.

WRITTEN POLICIES AND PROCEDURES: Ohio EPA developed written guidance on how to regulate cooling water intake structures in 1978 (updated by memoranda in 2005, 2008 and 2011).

GATHERING DATA: Ohio EPA takes a robust approach to data gathering. In some cases, the agency gathers background biological data itself. It also cooperates with other regulators and interstate bodies to conduct large-scale ecosystem assessments of waterbodies such as the Ohio River. Ohio EPA also requires dischargers to submit some degree of environmental data in the NPDES permit renewal process, and will also write letters suggesting that data be submitted between permit renewals as required.

TEXAS

OVERALL ENVIRONMENTAL PROTECTION: **LOW**
The Texas Commission on Environmental Quality regulates existing once-through cooling systems on a case by case basis. No particular technologies need be considered by permittees, and the permits provided by TCEQ suggest that the agency tends to accept the existing system as the "best technology available." Even though many Texan power plants are located on coastal estuaries rich in aquatic life, no power plant in Texas has ever been required to replace a once-through cooling system with closed-cycle cooling. TCEQ generally considers existing fish kills to be acceptable.

OVERVIEW OF TEXAS:
According to documents produced by the Texas Commission on Environmental Quality (TCEQ), Texas is home to at least 55 power plants and industrial facilities with cooling water intake structures. Unfortunately, these facilities never undergo closed-cycle cooling retrofits because TCEQ believes that the fish kills that occur at plants using less protective technologies are acceptable - they do not affect the overall quality of the waterbody.

Texas' 55 intakes are split into three separate groups. A sizeable fraction of Texas' plants were built on the Gulf Coast and draw cooling water directly from the Gulf or from the estuaries and lagoons that connect to the Gulf. None of these coastal power plants have ever been required to retrofit from once-through to closed-cycle cooling in order to reduce fish kills.

Many of Texas' remaining power plants were built alongside surface water impoundments (reservoirs or lakes) specifically designed to provide cooling water to the plant. The state of Texas considers plants adjacent to captive, man-made lakes to be using a form of closed-cycle cooling, even though many of these reservoirs were created by damming an existing river or creek.

With the original aquatic ecosystems in these waters altered beyond all recognition decades ago, many artificial lakes are now heavily managed ecosystems, deliberately stocked with sportfish. It is unclear whether TCEQ approaches the task of minimizing the adverse environmental impacts of impingement and entrainment on the fish living in these lakes differently than it does for coastal plants. But, like the coastal plants, no inland plant has ever been required to install closed-cycle cooling to protect fish. And TCEQ prefers not to reduce thermal discharges at these plants because the waste heat from a plant can benefit the managed sport fish species.

Finally, one power plant, the Victoria Power Station, is located inland on the Guadalupe River. It is the only riverine power plant in the state and was built with a hybrid system of once-through cooling and supplementary cooling cells.

The TCEQ has thousands of employees; it is one of the largest environmental regulators in the country and has the in-house capabilities to conduct complex biological and engineering analysis where necessary. But size may be a disadvantage for TCEQ when it comes to considering all of the different benefits that a cooling water intake structure will provide. For example, Texas is already an arid, drought-prone state, and many parts of the state rely heavily on groundwater at rates that significantly exceed aquifer recharge. Because of climate change, over the next century Texas is expected to become considerably hotter, more prone to periods of extreme drought, and may also become drier overall. Thus Texas likely would benefit from making its energy and water systems more climate-resilient. One option is to ensure that power plant capacity is not dependent on the volume

of surface water impounded for cooling purposes. This would also free up surface waters held in power plant reservoirs for other uses downstream. But the added benefits of climate resilience are not considered by TCEQ when it sets cooling water intake limits. According to TCEQ staff that work on cooling water intakes, climate change analysis happens "at the other end of the shop."

FACTORS

EASE OF EXECUTION: **EASY**. TCEQ appears to be content with the status quo. If EPA finalizes the cooling water intake standard it proposed in 2011—which asks state regulators to analyze cooling systems on a case-by-case basis and provides them virtually unlimited discretion in deciding how to minimize the adverse environmental impact of these systems—Texas will probably continue to approve the use of whatever cooling system happens to be in place with very little scrutiny, no matter how many fish, sea turtles, or other animals are killed.

TECHNOLOGY EVALUATION PROCESS: The TCEQ strongly believes that it should set cooling water intake requirements on a case-by-case basis. And, like several other states, Texas believes that it need not select the technology that most effectively reduces fish kills. Rather TCEQ believes that in may allow the use of less protective technologies on the grounds that the remaining fish kills are acceptable - they do not affect the overall quality of the waterbody. Facilities are encouraged to look at all available technologies, but there are no technologies whose consideration is mandatory.

BIOLOGY EVALUATION PROCESS: Texas gathers useful data, but doesn't put it to use. Texas generally requires power plants to submit at least one year of biological monitoring data, with samples taken twice monthly. Thus, Texas always has at least 26 data points at hand to evaluate the degree of impingement and entrainment occurring at a plant. But like other states that do little to protect their waterbodies, Texas does not act until it has clear proof that a cooling water intake causes a negative impact on the overall quality of the waterbody. By waiting for such proof to materialize, Texas ensures that improvements are few and far between.

RECONSIDERATION OF PAST BTA DETERMINATIONS: Texas has never required a power plant to retrofit a once-through cooling system to closed-cycle cooling. And in reissued NPDES permits provided by TCEQ, the state does not appear to revisit BTA determinations or to seriously challenge the claims of power plant owners. Instead, the Texan NPDES permits provided by TCEQ refer to the design of the cooling system as it was reported to TCEQ by the power plant operators, accept that design as BTA, and require that operations remain consistent with past practice.

WRITTEN POLICIES AND PROCEDURES: There is no standard operating procedure for making BTA determinations in Texas. Texas strongly supports a case-by-case approach to cooling water intakes rather than a fixed permitting policy.

GATHERING DATA: Texas uses the NPDES permit as its tool for getting required studies, so reaching a full BTA determination within a single permit term is not feasible. Ideally (but infrequently), BTA determinations will be made over two NPDES permitting cycles (i.e. within ten years). However, TCEQ reports that many recent BTA determinations and study cycles are incomplete for a variety of reasons, including the mothballing of some facilities and changes in federal regulations that led the state to stall its permitting.

RECLAIMED WATER: TCEQ does not have a policy requiring reclaimed water use. Nonetheless, several Texan facilities use reclaimed water.

ENDNOTES

1 U.S. EPA, National Pollutant Discharge Elimination System—Cooling Water Intake Structures at Existing Facilities and Phase I Facilities, 76 Fed. Reg. 22,246 (April 20, 2011).

2 J.F. Kenny et al., Estimated Use of Water in the United States in 2005, U.S. Geological Survey Report, Circular 1344 (2009), at 38, http://pubs.usgs.gov/circ/1344/pdf/c1344.pdf .

3 U.S. EPA, Environmental and Economic Benefits Analysis for Proposed Section 316(b) Existing Facilities Rule, EPA 821-R-11-002, March 28, 2011 ("2011 EEBA") at 5-3 and 5-8.

4 Committee on Sea Turtle Conservation, National Research Council (U.S.), Decline of the sea turtles: causes and prevention, at 112, National Academies Press (1990) [DCN 10-4845]; see also Florida Power & Light Co., *Assessment of the Impacts of the St. Lucie Nuclear Generating Plant on Sea Turtle Species Found in the Inshore Waters of Florida,* at 5 (August 1995) [DCN 10-5516] (Exh. 15) (The St. Lucie plant has impinged five species of endangered sea turtles—loggerhead, green, Kemp's ridley, leatherback and hawksbill).

5 76 Fed. Reg. at 22,244 (col. 2-3).

6 U.S. EPA, Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities, 69 Fed. Reg. 41,576, 41,586 (July 9, 2004).

7 69 Fed Reg. at 41,587–88.

8 Versar, Technical Review and Evaluation of Thermal Effects Studies and Cooling Water Intake Structure Demonstration of Impact for the Salem Nuclear Generating Station at § VI-4 (Revised Final Report) (1989) (Exh. 4) (reported on an "equivalent adult" basis). 30 million pounds of bay anchovy and weakfish are lost each year due to entrainment and impingement at Salem compared to 6.8 million pounds of yearly commercial landings between 1975-1980.

9 67 Fed. Reg. at 17,138.

10 *Id.*

11 The Lovett and Danskammer plants have since closed.

12 67 Fed. Reg. at 17,138, citing John Boreman and Phillip Goodyear, *Estimates of Entrainment Mortality for Striped Bass and Other Fish Species Inhabiting the Hudson River Estuary,* American Fisheries Society Monograph 4:152-160, 1988 (Exh. 8).

13 67 Fed. Reg. at 17,139 (col. 1), citing S. Swarbrick and R.F. Ambrose (1988). On June 7, 2013, Southern California Edison announced it would shut down the San Onofre nuclear power plant.

14 Kinetrics, *Bay Shore Power Plant Cooling Water Intake Structure Information and I&E Sampling Data* (January 2008) (Exh. 11), also available at http://www.epa.state.oh.us/portals/35/permits/bayshore_IE_data_collection.pdf. Fortunately, Bayshore's fish kills have since dropped because, in September 2012, FirstEnergy (the power company that owns Bayshore) shut down three of the plant's four electricity generating units.

15 Christine Mayer, University of Toledo, Effects of Bayshore Power Plant on Ecosystem Function in Maumee Bay, Western Lake Erie, Annual Progress Report to NOAA: October 2010-February 2011 (Exh. 12), also available at http://www.utoledo.edu/as/lec/research/be/docs/maumee_bay_mayer_etal_annual_r.pdf.

16 Public Service Commission, Wisconsin Department of Natural Resources, Final EIS for the Elm Road Power Plant, Chapter 8; see also Sierra Club, Giant Fish Blenders: How Power Plants Kill Fish & Damage Our Waterways (And What Can Be Done To Stop Them), July 2011.

17 76 Fed. Reg. at 22,239 (col. 1). EPA uses the concept of "age-one equivalence" to compare the significance of killing organisms of different ages. For example, if out of 100 fish eggs, only ten survive to grow into one-year old fish, EPA considers ten one-year old fish to be the equivalent of 100 eggs. This adult or age-1 "equivalent" method, however, is not a valid method of measuring or comparing ecological value. First, the ratios of eggs to larvae to adults differs enormously across aquatic species, and not all are well studied. Second, even if the conversion rate is accurate, it still devalues earlier life stages of fish. Large numbers of eggs and larvae are not merely "equivalent" to smaller numbers of adult fish. In addition to becoming juveniles and then adults in later life stages, eggs and larvae also play a highly significant role in the aquatic ecosystem, which equivalency metrics ignore. To think of 100 fish eggs as equivalent to 10 age-one fish only puts value on the 10 percent of eggs that survive to become fish. But the other 90 percent of the eggs are valuable too—they become a vital food source for different species of fish, shellfish, and microorganisms, and they sustain the richness and complexity of the aquatic ecosystem.

18 *See* Stephen Singer, "Warm Seawater Forces Connecticut Nuclear Plant Shutdown," Sea Coast Online http://www.seacoastonline.com/apps/pbcs.dll/article?AID=/20120813/NEWS/120819916/-1/NEWSMAP (Aug. 13, 2012).

19 *See* Michelle T. H. van Vliet, John R. Yearsley, Fulco Ludwig, Stefan Vögele, Dennis P. Lettenmaier and Pavel Kabat, "Vulnerability of US and European electricity supply to climate change," 2 *Nature Climate Change* 676 (June 3, 2012), Digital Object Identifier (available at): 10.1038/nclimate1546

20 EPA, Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule 6-8 (2011) ("2011 TDD").

21 *See, e.g.,* 2011 TDD, ch. 6 (reviewing and dismissing from further consideration technologies including louvers, aquatic filter barriers, and certain screen designs).

22 *See, e.g.,* Proposed Rule, 76 Fed. Reg. at 22,203 (proposed April 20, 2011) (suggesting use of modified traveling screens or velocity reduction techniques to meet an impingement mortality standard, but then noting that "[t]his technology does not minimize adverse environmental impacts associated with entrainment.").

23 *See* Proposed Rule, 76 Fed. Reg. at 22,205 ("BTA impingement mortality controls [i.e., screens]. . . would achieve up to a 31 percent reduction [in mortality]."); *see also id.* at 22,202-203 (comparing various technologies).

24 *See* 66 Fed. Reg. at 65,256.

25 *See* Comments on EPA's Section 316(b) Stated Preference Survey, Dr. Frank Ackerman, Stockholm Environment Institute-US Center, Tufts University, July 10, 2012 available at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OW-2008-0667-3021;.

26 See EPA, Economic and Benefits Analysis for Proposed 316(b) Existing Facilities Rule (2011), at Table 6-3 ("2011 EBA").

27 R. McCullough, *Economics of Closed-Cycle Cooling in New York* (June 3, 2010), available at http://www.gracelinks.org/media/pdf/economics_ccc_ny.pdf.

28 *See* National Pollutant Discharge Elimination System—Cooling Water Intake Structures at Existing Facilities and Phase I Facilities, 76 Fed. Reg. 22,174, 22,218-19 (April 20, 2011).

29 *See* Comments on EPA's Section 316(b) Stated Preference Survey, Dr. Frank Ackerman, Stockholm Environment Institute-US Center, Tufts University, July 10, 2012 (on file with authors) (also available at http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OW-2008-0667-3021;.

30 *Id.*

31 *See* Riverkeeper Inc. v. U.S. Envt'l Protection Agency, 475 F.3d 83 (2d Cir. 2007) (hereinafter "Riverkeeper II").

32 Examples of such statements can be found in the administrative record that EPA compiled in preparing its new rules. *See, e.g.,* Statements of NYS Dept. of Env. Cons., Division of Fish, Wildlife, and Marine Resources, provided to U.S. EPA, re Public Meeting to Discuss Adverse Environmental Impacts resulting from Cooling Water Intake Structures, p.1 [DCN 1-5025-PR] (June 29, 1998); Phase II Comment Letter from Peter Duncan, Deputy Commissioner of the Office of Natural Resources, NYS DEC, to EPA Proposed Rule Comment Clerk, re the NPDES

Proposed Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities, August 7, 2002, Comment 1.38, p. 2; Phase II Comment Letter from Dennis Hart, Assistant Commissioner, Environmental Regulation, New Jersey Department of Environmental Protection, to EPA Proposed Rule Comment Clerk, re Cooling Water Intake Structures (New Facilities), November 9, 2000, DCN Comment 1.54, p. 4 ; Phase II Comment Letter from Bradley M. Campbell, Commissioner, New Jersey Department of Environmental Protection, to EPA Proposed Rule Comment Clerk, re Cooling Water Intake Structures (Existing Facilities), Aug. 8, 2002, Comment 2.002 (explaining that site-specific options are "likely to result in protracted dialogue between the permitee and the regulatory agency, undue and wasted effort, and delayed implementation of the required improvements."). Phase II Comment Letter from Gary Aydell, Technical Advisor, Office of the Secretary, Louisiana Department of Environmental Quality, to EPA Proposed Rule Comment Clerk, re Cooling Water Intake Structure (Existing Facilities: Phase II) Proposed Rule, August 8, 2002, DCN Comment 2.1, p. 1; November 7, 2000 letter from Michigan Dept. of Natural Resources to EPA; Phase II Comment Letter from Bill McCracken, Chief of Permits Section, Surface Water Quality Division, Michigan Department of Environmental Quality, re 316(b) Burden, January 24, 2002 [DCN 4-0049]; Phase II Comment Letter from Mark Vickery, P.G., Executive Director, Texas Commission on Environmental Quality to EPA, July 19, 2011, at p. 4 (EPA-HQ-OW-2008-0667-1970); Phase II Comment Letter from Donald R. Carlson, P.E., Chief, Industrial Programs Section, Bureau of Water, Kansas Department of Health and Environment to EPA, July 1, 2011, p. 6 (EPA-HQ-OW-2008-0667-1598); Letter from Jeff Udd, Acting Supervisor, Industrial Water Quality Permits Unit, Minnesota Pollution Control Agency to EPA, June 30, 2011, at p. 1-2 (EPA-HQ-OW-2008-0667-1631); Letter from Susan R. Sylvester, Acting Director, Bureau of Watershed Management, Wisconsin Department of Natural Resources to EPA, July 13, 2011, p. 4-5 (EPA-HQ-OW-2008-0667-2063).

33 *See* 66 Fed. Reg. at 65,262-63, 65,292; *see also Riverkeeper, Inc. v. United States EPA,* 358 F.3d 174, 196-197 (2d Cir. 2004) ("We think that the EPA's focus on the number of organisms killed or injured by cooling water intake structures is eminently reasonable.") (hereinafter "Riverkeeper I").

34 *See* Riverkeeper I, 358 F.3d at 190 ("Congress provided for a water quality standards approach to thermal discharges [in Section 316(a)] but did not include that approach (or make any reference to it) in the very next subsection"), *Riverkeeper Inc. v. U.S. Envt'l Protection Agency,* 475 F.3d 83, (2d Cir. 2007) ("EPA exceeded its authority under Section 316(b) by permitting . . . assessment of the quality of the receiving water (i.e., the receiving water's wildlife levels)") (hereinafter "Riverkeeper II"), see also *Entergy Corp. v. Riverkeeper, Inc.,* 129 S. Ct. 1498, 1510 (2009) (explicitly leaving in place the Second Circuit's remand of EPA's rules because they improperly called for water-quality based analysis that is prohibited under Section 316(b)).

35 66 Fed. Reg. at 65,285 (col. 2).

36 66 Fed. Reg. at 65,285 (col. 2).

37 Statements of NYS Department of Environmental Conservation, Division of Fish, Wildlife, and Marine Resources, provided to U.S. EPA, re Public Meeting to Discuss Adverse Environmental Impacts resulting from Cooling Water Intake Structures, p.1 [DCN 1-5025-PR] (June 29, 1998).

38 Phase II Comment Letter from Bill McCracken, Chief of Permits Section, Surface Water Quality Division, Michigan Department of Environmental Quality, re 316(b) Burden, [DCN 4-0049] (January 24, 2002).

39 Phase II Comment Letter from Dennis Hart, Assistant Commissioner, Environmental Regulation, New Jersey Department of Environmental Protection, to EPA Proposed Rule Comment Clerk, re Cooling Water Intake Structures (New Facilities), DCN Comment 1.54, p. 4 (November 9, 2000) (on file with Super Law Group, LLC); see also Phase II Comment Letter from Bradley M. Campbell, Commissioner, New Jersey Department of Environmental Protection, to EPA Proposed Rule Comment Clerk, re Cooling Water Intake Structures (Existing Facilities), Comment 2.002 (August 8, 2002) (on file with Super Law Group, LLC) (explaining that site-specific options are "likely to result in protracted dialogue between the permitee and the regulatory agency, undue and wasted effort, and delayed implementation of the required improvements.").

40 Phase II Comment Letter from Peter Duncan, Deputy Commissioner of the Office of Natural Resources, NYS DEC, to EPA Proposed Rule Comment Clerk, re the NPDES Proposed Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities, Comment 1.38, p. 2 (August 7, 2002).

41 *See* 40 C.F.R. § 125.98(a) (requiring that permit writers review all materials and make a BTA determination with each permit renewal), *see also* EPA Region 1, *MA0003654 Determinations Document* [BTA Determination for Brayton Point power plant] at 7-1 (July 22, 2002) ("Case law and EPA guidance directs that . . . § 316(b) determinations must be revisited with each permit reissuance."). The need to revisit a technology-based standard like Section 316(b) with every permit renewal is also inherent in the requirement that intakes be subject to the *best* technology available. Because the performance and availability of technologies change over time, a permit writer must establish a reasonable basis for determining that an existing condition of a permit reflects the best technology available at the time of renewal.

42 *See* 66 Fed. Reg. at 65,263 (col. 2).

43 See 2011 EEBA at 2-1.

44 See 2011 EEBA at 4-6 ("Unharvested fish, which were not assigned direct use value in this analysis, constitute the majority—97 percent—of the total loss.").

45 See EPA, Environmental and Economic Benefits Analysis of the Proposed Section 316(b) Existing Facilities Regulation at 4-1 (March 28, 2011).

46 *See* U.S. Fish and Wildlife Service, 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, available at http://wsfrprograms.fws.gov/Subpages/NationalSurvey/2011_Survey.htm

47 See Lenfest Forage Fish Task Force, *Little Fish, Big Impact: Managing a Crucial Link in Ocean Food Webs* 62-63 (April 3, 2012), available at http://www.oceanconservationscience.org/foragefish.

48 NY DEC, CP-#52 / *Best Technology Available (BTA) for Cooling Water Intake Structures* at 6 (July 2011), available at www.dec.ny.gov/docs/fish_marine_pdf/btapolicyfinal.pdf.

49 *See, e.g., In re Pub. Serv. Co. of N.H.* (Seabrook Station, Units 1 and 2), No. 76-7, 1977 WL 22370 (June 10, 1977), remanded on other grounds, 572 F.2d 872 (1st Cir. 1978); *In re Central Hudson Gas & Elec. Corp.,* Op. EPA Gen. Counsel, NPDES No. 63, 1977 WL 28250, at *8 (July 29, 1977).

50 For example, PSEG, the owner of the Mercer power plant in New Jersey, submitted a regulatory study in 2008 in which the company argued that non-use benefits should be monetized only when there is substantial harm to threatened and endangered species or other major ecological impacts and that, therefore, it could avoid monetizing non-use benefits and could submit a monetized cost-benefit analysis that set the value of most impinged fish at zero. *See* PSEG Services Corporation, *Comprehensive Demonstration Study for Mercer Generating Station, NJPDES Permit No. NJ0004995,* page 44 (June 30, 2008). Dayton Power & Light, the owners of the Stuart power plant in Ohio, wrote to Ohio EPA that "it is difficult to identify any environmental benefit at all" to closed-cycle cooling. Letter from William L. Patberg, Attorney for Dayton Power & Light to Paul Novak, Ohio EPA (April 9, 2003). In another example, FirstEnergy, the owner of the Bayshore power plant in Ohio, claimed that closed-cycle cooling cannot pass a cost-benefit test at that plant, even though it is located in one of the richest inland estuaries in the United States and was (before three of its four units were shut down in 2012) killing more than 60 million adult fish and 12 billion eggs and larvae every year.

51 *See, e.g.,* Intergovenmental Panel on Climate Change, Climate Change 2007: Synthesis Report p.46 (Nov. 2007) available at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf ("Warming is expected to be greatest over land and at most high northern latitudes . . . snow cover area is projected to contract . . . [i]t is very likely that hot extremes, heat waves and heavy precipitation events will become more frequent . . . , it is likely that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea-surface temperatures.")

52 *See* Michelle T. H. van Vliet, John R. Yearsley, Fulco Ludwig, Stefan Vögele, Dennis P. Lettenmaier and Pavel Kabat, "Vulnerability of US and European electricity supply to climate change," 2 *Nature Climate Change* 676 (June 3, 2012), Digital Object Identifier (available at): 10.1038/nclimate1546

53 San Antonio Water System. SAWS Water Recycling Facts. http://www.saws.org/Your_Water/Recycling/Centers/facts.cfm

54 Riley, Ethan. Palo Verde Overview. Arizona Emergency Information Network. February 24, 2011. http://www.azein.gov/azein/Shared%20Resources/PVNGS%20Media%20Kit/Palo%20Verde%20Overview.pdf

55 Cooper, I. Reusing Municipal Wastewater for Power Generation Cooling Towers - Opportunities and Obstacles. Summer 2012. http://www.golder.com/global/en/modules.php?name=Publication&sp_id=255&page_id=212

56 Radisav D. Vidic & David A. Dzombak, University of Pittsburgh Department of Civil and Environmental Engineering, *Reuse of Treated Internal or External Wastewaters in the Cooling Systems of Coal-Based Thermoelectric Power Plants* at 5-27 (2009).

57 National Energy Technology Laboratory, Use of Non-Traditional Water for Power Plant Applications: An Overview of DOE/NETL R&D Efforts at viii (2009), available at http://www.netl.doe.gov/technologies/coalpower/ewr/water/pdfs /Use%20of%20Nontraditional%20Water%20for%20Power%20Plant%20Applications.pdf.

58 Electric Power Research Institute, *Use of Alternative Water Sources for Power Plant Cooling* at 2-23 (2008).

59 *See* California State Water Resources Control Board, *Statewide Water Quality Control Policy on the Use of Coastal and Estuarine Water for Power Plant Cooling* (amended July 19, 2011) at § 1.M ("To conserve the State's scarce water resources, the State Water Board encourages the use of recycled water for cooling water in lieu of marine, estuarine or fresh water.") available at http://www.swrcb.ca.gov/water_issues/programs/ocean/cwa316/docs/otc_clean.pdf.

60 Vidic, R. D., Dzombak D. A., et al. Reuse of Treated Internal or External Wastewaters in the Cooling Systems of CoalBased Thermoelectric Power Plants. September 2009. http://www.netl.doe.gov/technologies/coalpower/ewr/water/pp-mgmt/pubs/06550/42722FSRFG063009.pdf

61 *See* California State Water Resources Control Board, *Statewide Water Quality Control Policy on the Use of Coastal and Estuarine Water for Power Plant Cooling* (amended July 19, 2011), available at http://www.swrcb.ca.gov/water_issues/programs/ocean/cwa316/docs/otc_clean.pdf. Since the policy was adopted, two plants have closed and one has repowered to a closed-cycle cooling system, leaving 16 once-through power plants in California.

62 *See* 23 CCR 2922.

63 Policy § 5 (Definition of Terms) (emphasis added).

64 California State Water Resources Control Board. Ocean Standards - CWA §316(b) Regulation. http://www.swrcb.ca.gov/water_issues/programs/ocean/cwa316/powerplants/index.shtml.

65 Illinois did not respond to a request for public documents or to follow-up inquiries. Therefore, this analysis is based only on review of permits and discussion with knowledgeable environmental advocates.

66 The twelve years consists of the five years of the NPDES permit's term, 2000-2005, plus the seven years from 2005-2012 during which Waukegan operated on an expired permit.

67 Maryland Power Plant Research Program, Section 316(b) of the Clean Water Act: Cooling Water Intake Structure Regulations; Consequences for Maryland Power Plants, http://esm.versar.com/pprp/316/Consequences.htm.

68 Phase II Comment Letter from Dennis Hart, Assistant Commissioner, Environmental Regulation, New Jersey Department of Environmental Protection, to EPA Proposed Rule Comment Clerk, re Cooling Water Intake Structures (New Facilities), DCN Comment 1.54, p. 4 (November 9, 2000) (on file with Super Law Group, LLC).

69 New York State Department of Environmental Conservation. CP-#52 / Best Technology Available (BTA) for Cooling Water Intake Structures. July 10, 2011. http://www.dec.ny.gov/docs/fish_marine_pdf/btapolicyfinal.pdf.

70 Policy at 4-5.

71 DEC Takes Action To Protect Aquatic Life, Limit Water Intake by Certain Industrial Facilities. New York State Department of Environmental Conservation. March 10, 2010. http://web.archive.org/web/20101124071540/.

72 *Id.*

73 Proposed 40 C.F.R. § 125.92, 76 Fed. Reg. at 22,282.

74 Ohio BTA guidance p.37.

TREADING WATER

How States Can Minimize the Impact of Power Plants on Aquatic Life