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The Economic Benefits of the Mercury and Air Toxics Standards (MATS) Rule to the Commercial and Recreational Fishery Sectors of Northeast and Midwest States

Final Report | 17 April 2019

prepared for:

Commonwealth of Massachusetts,
Office of the Attorney General

State of Illinois, Office of the Attorney General

State of Minnesota, Pollution Control Agency

State of New Jersey, Department of Environmental Protection

State of New York, Office of the Attorney General

State of Rhode Island, Office of the Attorney General

prepared by:

Robert E. Unsworth (Principal),
Dr. Heather Balestero (Associate),
Shikha Chivukula (Research Analyst),
Maura Flight (Principal),
Eric Horsch (Senior Associate), and
Christopher Smith (Technical Consultant)

Industrial Economics, Incorporated

2067 Massachusetts Avenue

Cambridge, MA 02140

617/354-0074

This report was prepared in response to:

EPA's Proposed Revised Supplemental Finding for the Mercury and Air Toxics Standards, and Results of the Residual Risk and Technology Review

Re: National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units—Reconsideration of Supplemental Finding and Residual Risk and Technology Review.

Docket ID No. EPA-HQ-OAR-2018-0794. Federal Register Vol. 84, No. 26, Thursday, February 7, 2019. Proposed Rules.

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THE ECONOMIC BENEFITS OF THE MERCURY AND AIR TOXICS STANDARDS (MATS) RULE TO THE COMMERCIAL AND RECREATIONAL FISHERY SECTORS OF NORTHEAST AND MIDWEST STATES

INTRODUCTION AND PURPOSE OF THIS REPORT

On December 27, 2018, the U.S. Environmental Protection Agency (EPA) proposed to revise the Supplemental Cost Finding for the Mercury and Air Toxics Standards (the "MATS Rule"), as well as to complete the Clean Air Act (CAA) required risk and technology review associated with the MATS Rule (EPA 2018). On February 7, 2019 EPA published and asked for public comment on a Proposed Rule (EPA 2019). Specifically, EPA proposes to compare the cost of compliance with the MATS Rule solely with what EPA maintains are the direct, monetized benefits specifically associated with reducing emissions of the hazardous air pollutant (HAP) mercury in order to satisfy the duty to consider cost in the context of the CAA section 112(n)(1)(A) "appropriate and necessary" finding (U.S. EPA 2019, pp. 2674). While EPA states that there are unquantified HAP benefits and significant monetized particulate matter (PM) co-benefits associated with the MATS Rule, it notes the Administrator has concluded that the identification of these benefits is not sufficient, in light of what EPA has characterized as the "gross" imbalance of monetized costs and HAP benefits, to support a finding that it is appropriate and necessary to regulate Electric Generating Units (EGUs) under CAA section 112 (EPA 2019, pp. 2677).

Reopening the MATS Rule could result in a lifting of regulatory limits on mercury emissions from EGUs in the United States. This regulatory change could generate a significant increase in mercury emissions from the source category, leading to higher mercury levels in waterbodies that are subject to atmospheric deposition and loadings of mercury. An increase in atmospheric loadings would in turn increase mercury levels in the edible portions of recreationally and commercially harvested fish and shellfish. Given that state and federal agencies, as well as non-governmental entities, provide guidance to recreators and consumers to limit their exposure to mercury from consumption of fish and shellfish, any increases in mercury levels could result in changes in recreator and consumer behaviors. These behavioral changes would have an adverse impact on the wellbeing of recreators and negative consequences for the regional economies of the Northeast and Midwest.

The purpose of this report is to assess the potential impact of elevated mercury fish tissue contamination on the recreational and commercial fishing industries of the Northeast and Midwest,[1] as well as the scale of the potential economic benefits of the MATS Rule on those regionally-important economic sectors. Specifically, we ask the following questions:

- *To what extent do power plant emissions contribute to mercury in the environment, particularly in sportfish and commercially harvested fish tissue (as compared to other sources)?*
- *What actions have Northeast and Midwest states and federal agencies taken to limit the public's exposure to mercury from freshwater and saltwater fish consumption in order to protect public health (i.e., recreationally caught fish consumption advisories (FCAs); commercially harvested seafood health guidelines)?*[2] *What information do recreators and consumers receive from non-governmental organizations on the risks of exposure to mercury from self-caught and commercially caught fish species.*
- *How do FCAs affect anglers' propensity to fish and the associated economic benefits of recreational fishing, including consumer surplus (i.e., values incurred by anglers) and regional economic contributions (i.e., jobs, income) from fishing trip expenditures? How do health guidelines on commercially harvested seafood affect demand for commercially important species, and by extension consumer and producer surplus and jobs/economic activity across the broader regional economy?*
- *What is the scale of recreational fishing activity in the Northeast and Midwest? What is the scale of economic activity associated with commercial catch and revenues? Given the scale of these activities, what is the potential economic benefit of the MATS Rule?*
- *Could EPA estimate the change in economic wellbeing and regional economic activity that has and could result from maintaining the MATS Rule?*

Our findings, described in detail below, are as follows:

- Emissions of mercury from coal-fired EGUs are a significant contributor to total mercury levels in fish and shellfish in the Northeast and Midwest states.

[1] We consider the following states in this report: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont for the Northeast; and Illinois, Michigan, Minnesota, and Wisconsin for the Midwest. However, we note that the benefits of the MATS Rule described in this report also likely exist for other states experiencing elevated fish tissue concentrations of mercury due to emissions from EGUs.

[2] References to "seafood" in this report include fish harvested commercially from both marine and freshwater.

- The existing MATS Rule, effective since 2015, has reduced mercury loadings to aquatic systems, in turn leading to a reduction in mercury levels in fish and shellfish.
- Given the health risks posed by mercury to human health, federal and state agencies have acted to put in place consumption advisories for fish and shellfish harvested commercially, recreationally, and by subsistence fishers.
- These advisories are intended to change individuals' behavior and thus protect sensitive populations and the general public from the health risks of mercury.
- In addition, non-governmental organizations and private businesses provide consumers with information on the risks of consuming fish and shellfish that are high in mercury.
- The public has been shown to respond to these advisories and other sources of information by changing their recreational and subsistence behaviors, as well as their consumption patterns for commercially harvested fish and shellfish.
- The total contribution to economic welfare in the 12 states considered in this analysis resulting from recreational fishing activity is approximately $7.5 billion *per year*.
- Recreational fishing and commercial fish and shellfish harvest and processing are substantial contributors to the regional economies of the Northeast and Midwest. While the specific contributions vary from year to year, recreational fishing contributes $16 billion (2019 dollars) in value added annually (i.e., contribution to regional GDP) to the economies of 12 states in these regions, and approximately 259,000 jobs.[3] Additionally, annual commercial fish landings for these 12 states generate $1.6 billion in value added annually (specific estimate is variable from year to year), and approximately 18,000 jobs.
- Adverse changes in recreational behavior and purchase patterns for commercially harvested fish and shellfish reduces economic welfare (e.g., consumer surplus) and regional economic activity (e.g., jobs and expenditures) in the Northeast and Midwest states.[4] The magnitude of economic impacts increases as contamination worsens and FCAs become more restrictive.

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[3] In the context of regional economic impact analysis, which reflects a single-year snapshot of impacts on economic activity levels in a region, the metric "jobs" refers to "job-years," defined as one job lasting one year.

[4] Consumer surplus is the difference between the price of the good or service and the amount we would be willing to pay for that good or service before we would forgo consumption. In the case of recreational behavior, if the cost of a day of fishing (i.e., the cost of getting to a fishing site and the opportunity cost of not working) is less than the participant's willingness to pay for the experience, the individual experiences a gain in consumer surplus (i.e., social welfare). When the quality of a recreational experience declines, the consumer surplus also declines, reflecting a lower willingness to pay for the experience.

- Given the importance of recreational fishing and the commercial fishing and processing sectors to the economies of the Northeast and Midwest, even modest changes in recreator and consumer behavior in response to reductions in mercury concentrations from the MATS Rule are likely to result in substantial benefits to the economies and residents of these states and the Nation as a whole. While this report does not evaluate the specific effects of the MATS Rule on contaminant and FCA levels, this analysis does find that it is reasonable to conclude that the Rule may generate recreational and commercial fishing benefits in excess of $1 billion *annually*.
- There are widely accepted methods that EPA could have used to monetize the benefits of reduced mercury concentrations in recreationally caught and commercially harvested fish. These benefits would include both regional economic performance (including jobs and expenditures) as well as social welfare benefits. However, despite the availability of these methods, neither the previous EPA rulemaking nor the current proposed rulemaking attempt to measure these benefits or even describe them qualitatively.

THE ROLE OF POWER PLANT EMISSIONS IN CONTRIBUTING TO MERCURY CONCENTRATIONS IN FISH AND SHELLFISH

Mercury (Hg) is an element found throughout the environment. It exists in elemental (metallic), organic (methylmercury), and inorganic forms. Natural sources of mercury enter the environment from volcanic activity, forest fires, and weathering of rocks (UNEP 2019). Anthropogenic sources of mercury include fossil fuel combustion, artisanal and small-scale gold mining and other mining activities, industrial activity, and incineration of waste (Giang and Selin 2016, UNEP 2019, Driscoll *et al.* 2013, Pacyna *et al.* 2010). In addition to primary sources of mercury, mercury can be remobilized from environmental sources (e.g., soil, sediment, water) where previously deposited (UNEP 2019, Giang and Selin 2016).

While mercury is an element and is thus naturally occurring, atmospheric deposition of mercury has increased by a factor of two to five since preindustrial times, with even higher increases in deposition rates in industrialized areas (Fitzgerald *et al.* 1998, Krabbenhoft and Sunderland 2013, Swain *et al.* 1992, UNEP 2019). Burning of fossil fuels—mainly coal—is a significant source of anthropogenic mercury, contributing 24 to 45 percent of total global anthropogenic mercury emissions (UNEP 2019, Pacyna *et al*. 2010). In North America, fuel combustion is the highest contributor of anthropogenic mercury emissions, estimated to be around 60 percent of total anthropogenic emissions. North American anthropogenic sources, on average, contribute roughly 20 to 30 percent of total mercury atmospheric deposition within the continental United States (Selin *et al.* 2007). The remainder comes from anthropogenic sources in other countries and from natural sources.

Mercury is released in the form of gaseous elemental mercury (Hg^0) from EGUs during combustion. Once in the atmosphere, it can be transported over short and long distances (Giang and Selin 2016, Driscoll *et al.* 2013). In the atmosphere, it reacts with oxidants to form water soluble inorganic mercury species (Hg^{II}) where it can then be deposited via precipitation to terrestrial and aquatic ecosystems. Some of this mercury is then cycled through aquatic systems where it can form organic mercury (methylmercury; Vijayaraghavan *et al.* 2014, Krabbenhoft and Sunderland 2013). Methylmercury, a known toxicant for wildlife and humans, is known to biomagnify through food chains, with higher trophic level organisms acquiring increasingly large body burdens (UNEP 2019). Nearly all the mercury in humans, fish, and predatory insects is in the form of methylmercury (Harris *et al*. 2007, Mason *et al.* 2000, Cristol *et al.* 2008, Driscoll *et al*. 2007). Overall, the proportion of methylmercury in organisms is a function of food chain length (Knightes *et al*. 2009). Fish are predominantly exposed to mercury in the water column (via atmospheric deposition), but are also exposed through contaminated sediments and terrestrial transport from the watershed where mercury has been stored (Harris *et al*. 2007, Mason *et al*. 2012). Humans are subsequently exposed to methylmercury via fish consumption.

The distance that emitted mercury can travel depends on the form emitted; elemental mercury (Hg^0) can transport further than particulate or mercury gas (Hg^{II}), which are generally deposited closer to the source (Giang and Selin 2016, Driscoll *et al*. 2013). Studies have suggested that, although the timeframe over which the impacts occur is uncertain, a reduction in inorganic mercury loading would directly reduce exposure of fish and subsequent mercury concentrations in fish (Vijayaraghavan *et al*. 2014, Mason *et al*. 2012, Selin *et al*. 2010, Harris *et al.* 2007, Krabbenhoft and Sunderland 2013, Giang and Selin 2016; Knightes *et al*. 2009).

Overall, there is broad agreement in the literature that a decline in anthropogenic mercury inputs will lead to a relatively proportional decrease in fish tissue concentrations (Giang and Selin 2016, Lee *et al*. 2016, Cross *et al*. 2015, Vijayaraghavan *et al*. 2014, Evers *et al*. 2011). Giang and Selin (2016) modeled various policies and mercury reduction scenarios on a national and global scale relative to a no policy scenario. Their results show that from the baseline of year 2005, by the year 2050, with the MATS Rule in place, there would be a 20 percent reduction in mercury deposition in the Northeast and a six percent reduction in deposition to global oceans relative to a no policy scenario. The authors note that, while reductions in mercury emissions will result in national reductions in exposure to mercury from fish consumption, there are potential uncertainties in predicting the timeframe associated with these benefits due to ecosystem dynamics, as well as mercury from sources outside the U.S. Other studies have modeled emission reductions in North America and subsequent regional reductions in mercury, noting that emission reductions would particularly affect mercury concentrations in fish in the Northeast (Selin *et al*. 2010). Lee *et al*. (2016) found a 19 percent decline in Atlantic bluefin tuna mercury concentrations from 2004-2012 relative to a 20 percent decline in North Atlantic mercury emissions from 2001-2009. With fewer samples, Cross *et al*.

(2015) found a similar reduction in bluefish tissue concentration from 1972 to 2011 in response to reductions in atmospheric deposition and other mercury inputs (e.g., point source).

Depending on where fish species reside in the water column, their prey, and the physiochemical parameters of the system, the response of mercury concentrations in fish to a reduction of mercury from EGUs will range from a rapid reduction over a few years or decades to long-term reductions over centuries (Vijayaraghavan *et al*. 2014, Knightes *et al*. 2009). For example, using a lake in New Hampshire as a modeled case study for mercury reductions in fish tissue, Vijayaraghavan *et al*. (2014) found it would take more than 50 years for fish tissue to proportionally reflect the reduction in atmospheric mercury deposition as a result of local and regional emissions reductions. However, fish tissue would begin to reflect reductions in atmospheric mercury deposition within three to eight years.

In short, while the timeframe of reductions in mercury concentrations in fish tissue in response to emissions reductions ranges, the relationship is clear: Policy changes requiring a reduction in mercury emissions from EGUs will reduce mercury deposition and subsequent fish tissue mercury concentrations. These changes in fish tissue mercury concentrations and human exposure from fish consumption will vary by location, species, and watershed and waterbody, but are expected to occur widely across the Northeast and Midwest.

ACTIONS STATES HAVE TAKEN TO LIMIT PUBLIC EXPOSURE TO MERCURY IN FISH AND SHELLFISH

As described above, coal-fired EGUs are a significant source of mercury emissions in North America. As such, emissions from this source are a significant contributor to mercury concentrations in fish and shellfish caught, purchased, and consumed in the United States. Federal and state agencies are responsible for disseminating information about mercury levels in self-caught and purchased fish products and encouraging safe consumption habits for members of the public. For example, by issuing FCAs, federal and state agencies seek to limit the population’s exposure to high mercury levels and avoid adverse health effects in the population, including especially sensitive populations (e.g., pregnant women, young children). In addition to governmental guidelines, popular seafood chains and retailers, public health research organizations, environmental and consumer advocacy groups, and educational organizations provide consumers with materials to encourage and facilitate safe fish consumption.

Federal and state agencies generally provide details on safe fish consumption behaviors based on waterbody, fish size and species, serving size, and serving frequency (see Exhibit 1 below). Consumption advisories are generally categorized as either targeting a sensitive population (i.e., pregnant women, women of childbearing age, young children, and adolescents) and general population, reflecting the role mercury plays in neurological development (U.S. Environmental Protection Agency 2017). Appendix A includes three examples of general statewide safe fish guidelines: Michigan and Vermont both provide a general list of fish species from their respective waterbodies, chemical(s) of concern, size of fish, and servings per month based on consumers' classification as a "sensitive population. Massachusetts lists advisories for specific waterbodies that include advice regarding which species of fish should be avoided by certain populations (or in some instances, all populations) based on the presence of certain contaminants. In addition to providing specific advisory information, the U.S. EPA, the U.S. Food and Drug Administration, and many states provide information on the risk of health effects of mercury exposure in humans, contextual information on bioaccumulation and biomagnification of mercury in fish, and undertake contamination monitoring and mitigation efforts.

EXHIBIT 1. EXAMPLES OF FEDERAL AND STATE MERCURY ADVISORIES AND GUIDANCE

JURISDICTION	HOW INFORMATION IS COMMUNICATED	EXAMPLE OF GUIDANCE	OTHER INFORMATION	SOURCE
U.S. Environmental Protection Agency	Webpages and factsheets	Recommended serving size and frequency for about 60 fish species based on their mercury levels for sensitive populations		http://www2.epa.gov/choose-fish-and-shellfish-wisely
U.S. Food and Drug Administration	Chart targeted at pregnant women and parents	Serving amount and size for "best", "good", and "to avoid" choices	Data collected from 1990 – 2012 of mercury levels in commercial fish and shellfish	https://www.fda.gov/Food/ResourcesForYou/Consumers/ucm393070.htm
State of Connecticut, Department of Public Health	Guides for fish caught in Connecticut waters and store-bought fish	Weekly/monthly serving amount for fish species for general and sensitive populations, monthly serving amount for fish species caught in Connecticut waterbodies		http://www.ct.gov/dph/cwp/view.asp?a=3140&q=387460&dphNav_GID=1828&dphPNavCtr=|#47464
State of Illinois, Department of Public Health	List of specific fish species with mercury advisories	Meal amount per week or month for fish species for general and sensitive populations	Interactive map of waterbodies per county that lists all the fish advisories, including pictures of each species	http://dph.illinois.gov/topics-services/environmental-health-protection/toxicology/fish-advisories
Commonwealth of Massachusetts, Department of Public Health	List of waterbodies/towns in Massachusetts with fish consumption advice, guidelines for fish consumption for marine and fresh waterbodies	Advice is provided for fish species and recommended monthly fish consumption amounts for general and sensitive populations	Searchable directory of advisories per waterbody and town	http://www.mass.gov/dph/fishadvisories

JURISDICTION	HOW INFORMATION IS COMMUNICATED	EXAMPLE OF GUIDANCE	OTHER INFORMATION	SOURCE
State of Maine, Center for Disease Control & Prevention	Safe eating guidelines for freshwater fish in Maine waterbodies and saltwater bodies	Freshwater guide: recommended monthly serving amount Saltwater guide: serving amount for sensitive and general populations	Poster with images and a scale of fish-mercury levels in store-bought and self-caught fish; Maine Center for Disease Control and Prevention's Family Fish Guide which details fish type, size, serving amount, fish origin, and cooking methods are safe to eat for sensitive populations	http://www.maine.gov/dhhs/mecdc/environmental-health/eohp/fish/
State of Michigan, Department of Community Health	Statewide safe fish guidelines, and regional Eat Safe Fish Guides for species found in Michigan waterbodies	Serving size based on person's weight, size of fish caught, monthly serving suggestion, chemical of concern	Guide for safe serving amount of fish from a grocery store or restaurant that also includes information on omega-3 fatty acids	http://www.michigan.gov/eatsafefish
State of Minnesota, Department of Health	Safe eating guidelines for general and sensitive populations; list of Minnesota waterbodies and corresponding meal advice for general and sensitive populations	Serving amount and frequency of MN caught and purchased fish, fish size	Level of mercury in fish and corresponding meal frequency for general and sensitive populations	http://www.health.state.mn.us/divs/eh/fish/index.html
State of New Hampshire, Fish and Game Department	Fish consumption guidelines for freshwater and saltwater	Recommendations for monthly serving amount/size of fish, no specific information of species and water body guidelines easily accessible		http://www.wildlife.state.nh.us/fishing/consume-fresh.html
State of New Jersey, Departments of Environmental Protection and Health	List of all species in each waterbody with an advisory; there are separate lists for estuarine & marine waters, and inland waterbodies	Serving frequency for general and sensitive populations	Images of fish species; interactive map to locate waterbody specific advisories	http://www.state.nj.us/dep/dsr/njmainfish.htm
State of New York, Department of Health	List of advisories per waterbody in each region of the state	Fish species, serving frequency recommended for general and sensitive populations, chemicals of concern		https://www.health.ny.gov/environmental/outdoors/fish/health_advisories/

JURISDICTION	HOW INFORMATION IS COMMUNICATED	EXAMPLE OF GUIDANCE	OTHER INFORMATION	SOURCE
State of Rhode Island, Department of Health	Brochure targeted to pregnant women and parents	List of safe species of RI-caught fish and generally low mercury level fish		http://www.health.ri.gov/healthrisks/poisoning/mercury/about/fish/
State of Vermont, Department of Health	List of general fish consumption guidelines and for specific waterbodies	Fish species and serving frequency per general and sensitive populations		http://healthvermont.gov/health-environment/recreational-water/mercury-fish
State of Wisconsin, Department of Natural Resources	List of general and specific waterbody fish consumption advisories	Fish species, fish size, serving frequency for general and sensitive populations	Search directory of county and advisory area (waterbody)	http://dnr.wi.gov/topic/fishing/consumption/

Consumers also can access information on fish and shellfish safety, health benefits/effects, and consumption from additional sources. Retail chains, research organizations/academic institutions, environmental advocacy groups, and consumer protection groups publish contextual information on mercury consumption, and safe consumption guidelines. These sources of information can sometimes be redundant of state and federal guidelines, and are designed to be supplemental to official advisories, to ensure that consumers have all pertinent information available to them prior to purchasing or consuming potentially toxic fish product. Some of these sources include:

- The grocery chain Whole Foods publishes "Mercury in Seafood: Frequently Asked Questions" which explains the health concerns of elevated levels of methylmercury in fish, and lists fish species safe for consumption, while referring to EPA and FDA guidelines;
- The Safina Center at Stony Brook University's "Mercury in Seafood: A Guide for Consumers" recommends serving size for several popular fish species and discusses risks and signs of methylmercury exposure. The Safina Center also publishes brochures for health care professionals and a full report on mercury in the environment;
- The Gelfond Fund for Mercury Research & Outreach's "Seafood Mercury Database" aggregates government data and scientific literature of mercury levels in commercial fish in the U.S.;
- Environmental Working Group publishes a "Consumer Guide to Seafood" and has an interactive "Seafood Calculator" tool that allows users to input their weight and basic health condition to get specific recommendations of species of serving size based on mercury content, omega-3 fatty acid content, and sustainability; and

- Environmental Defense Fund's "Seafood Selector" gives recommended serving size of fish species based on age, the fish species' eco-rating, contaminant level, and omega-3 level.

FCAs aim to reduce the amount of fish consumed to safe levels, and/or suggest safer alternatives for consumers (e.g., switching species consumed). Research on the role of advisories on consumer behavior suggests that they are a useful public health tool in reducing methylmercury exposure levels in sensitive human populations. An analysis of the effectiveness of advisory scenarios on minimizing blood-mercury levels in humans from fish consumption suggests that strategies that aim to reduce methylmercury exposure through reducing fish consumption overall are more effective than strategies intended to encourage safer alternative species (Carrington *et al.* 2004). One study focused on responses to an FDA advisory in 2001 found that information-based advisories can achieve the agency goal of minimizing consumption of mercury in fish if the advisories are targeted toward the sensitive populations of pregnant women, children, and women of child-bearing age (Shimshack, Ward, and Beatty 2007). Shimshack *et al.* found that education and readership were determinants of people's responses to fish health advisories, suggesting that advisories need to be more accessible and targeted towards the highest risk and lowest educated population to ensure FDA's goals of reducing exposure to mercury from fish consumption through reduced purchases and therefore consumption of fish products (2007). Furthermore, a survey study by the Epidemic Intelligence Service at the Centers for Disease Control demonstrated that awareness of sport fish health advisories in Midwest states among women, people of color, and persons with lower educational attainment is low compared to traditionally targeted licensed angles who tend to be white men (Tilden *et al*. 1997). This finding suggests that accessible and targeted communication of the risks and health effects associated with fish consumption are crucial in effectively decreasing mercury exposure through consumption (Tilden *et al.* 1997).

THE ROLE OF ADVISORIES AND HEALTH GUIDELINES IN ANGLER AND CONSUMER BEHAVIOR

While advisories are likely to reduce the public's exposure to mercury by modifying consumption patterns of fish and shellfish, these behavioral changes reduce social welfare and adversely impact regional economies. In this section we consider impacts to both recreational anglers as well as consumers purchasing fish and shellfish commercially sold in the marketplace.

RECREATIONAL FISHING

Numerous published studies have identified the negative impact that FCAs have on the quantity and quality of recreational fishing trips. The primary reason that anglers change their behavior in response to FCAs is because they are concerned about consuming species covered by the FCA or sharing it with friends and family. Since some anglers may practice catch-and-release fishing, they may not be affected. However, since many anglers fish to keep and consume their catch, FCAs do have an impact on recreational fishing behavior.

When recreational anglers change their behavior, there are two types of economic losses: 1) lost social welfare value of fishing to recreationists (i.e., the consumer surplus they experience from fishing) and 2) lost regional economic activity. The term social welfare value refers to the difference between the maximum amount a recreationist would be willing to pay to participate in a recreational activity and the actual cost of participating in that activity. This is referred to by economists as consumer surplus or net economic value.

A decline in value for recreational fishing trips can arise for the following reasons:

- Anglers may continue to fish at affected sites, but enjoy their fishing less (i.e., diminished use);
- Anglers may choose to fish at other sites (i.e., substitute use); and
- Anglers may forgo fishing entirely (i.e., lost use).

The behavioral responses above and losses in economic value have been documented for mercury-based advisories (e.g., Tang *et al*. 2018; Jakus and Shaw 2003; Jakus *et al*. 2002; Hagen *et al*. 1999; Chen and Cosslett 1998; MacDonald and Boyle 1997) as well as for other contaminants (e.g., MacNair and Desvousges 2007; Morey and Breffle 2006; Hauber and Parsons 2000; Parsons *et al*. 1999; Jakus *et al*. 1998, 1997; and Montgomery and Needelman 1997). Claims for lost economic value due to recreational mercury-based fishing advisories have been developed for several natural resource damage assessments (NRDAs) (e.g., Confederated Tribes of the Colville Reservation *et al*. 2012; Texas General Land Office *et al*. 2001; IEc 2017).

Economic value is distinct from the amount that anglers actually spend on their trips, such as gasoline to fuel their vehicles to reach a site or to make purchases of fishing gear. These expenditures support regional economic activity in the form of jobs and income.[5] When anglers take fewer trips or spend less money on their trips due to FCAs, there is a decline in regional economic activity associated with recreational fishing.

In the sections below, we summarize available literature on behavioral responses of recreational anglers to FCAs and the resulting impacts on economic value and regional economic activity. The discussion emphasizes impacts from mercury-based FCAs, but includes impacts from other contaminants (e.g., polychlorinated biphenyls or PCBs) to provide additional perspective on how FCAs affect behavior as the literature is reasonably consistent, regardless of contaminant source.

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[5] The summation of trip expenditures and economic value incurred when a trip is taken is called an angler's willingness to pay.

Changes In Recreator Behavior

Several studies, which are summarized in Exhibit 2, have demonstrated that anglers change their behavior in response to FCAs. The behavioral responses to FCAs include changing fishing destination (i.e., substitute use) and taking fewer trips (i.e., lost use), as well as other responses such as targeting different species, eating fewer fish or refraining from consumption entirely (including sharing it with others), and changing cooking methods.[6] While some anglers might not report changes in their behavior, they may still enjoy their fishing less (i.e., diminished trips) or have concerns about consuming their catch. Any of these behavioral responses results in a decline in value if the angler feels worse off than if the FCA were not present. Further, anglers may take fewer trips or spend less money on their trips due to FCAs, which results in a decline in regional economic activity.

Recent data demonstrate that recreational fishing is a popular activity in the Northeast and Midwest. Exhibit 3 presents estimates of annual fishing days taken to selected states in these regions and in total. Applying the range of percentages from Exhibit 2 to the user day estimates in Exhibit 3 results in a large estimated number of affected user days, which may be expressed either in terms of changes in participation, substitution, or diminished use or through other behavioral responses (e.g., changing target species, eating fewer fish). Losses in recreational fishing value associated with these behavioral responses are described in the next section.

EXHIBIT 2. RECREATIONAL ANGLER BEHAVIORAL RESPONSES TO FCAS

STUDY	LOCATION	BEHAVIORAL RESPONSES
USFWS and Stratus Consulting (1999)	Lower Fox River/ Green Bay	-30% spend fewer days fishing -31% change locations fished -23% target different species -45% change the species they keep to eat -47% change the size of fish they keep to eat -45% change the way they clean/prepare fish -25% change the way they cook fish
Connelly *et al*. (1990)	New York	-17% take fewer trips -31% change fishing locations -46% change cleaning/cooking methods -51% eat fewer fish from the site -17% eat different species -11% no longer eat fish from the site

[6] While changes in cooking and preparation methods can be effective for fat-soluble contaminants (e.g., PCBs), they are largely ineffective for mercury contamination since mercury does not concentrate in specific body tissues.

STUDY	LOCATION	BEHAVIORAL RESPONSES
Connelly *et al*. (1992)	New York	-18% take fewer trips -45% change cleaning methods -25% change the size of fish consumed -21% change cooking methods -70% eat less fish from the site -27% eat different species -17% no longer eat fish from the site
Connelly *et al*. (1996)	Lake Ontario	-79% use risk-reducing cleaning methods -42% use risk-reducing cooking methods -32% would eat more fish in the absence of FCAs
Kunth *et al*. (1993)	Ohio River	-37% take fewer trips -26% change fishing locations -26% change targeted species -23% change cleaning methods -17% change the size of fish consumed -13% change cooking methods -42% eat less fish from the site -13% no longer eat fish from the site
Vena (1992)	Lake Ontario	-16% take fewer trips -30% change fishing locations -20% change targeted species -31% change cleaning methods -53% eat less fish from the site -16% no longer eat fish from the site
MacDonald and Boyle (1997)	Maine	-15% would consume more fish -10% would fish more days -5% would fish more waters -5% would fish different waters
Silverman (1990)	Michigan	-10% take fewer trips -31% change fishing locations -21% change targeted species -56% change cleaning methods -41% change the size of fish consumed -28% change cooking methods -56% eat less fish from the site -31% eat different species
West *et al*. (1993)	Michigan	-86% change cooking methods (Great Lakes anglers) -80% eat different species (Great Lakes anglers) -46% eat less fish from the site (overall) -27% change cooking methods (overall) -80% are aware of advisories; of these 80%, 75% change cleaning methods

EXHIBIT 3. ESTIMATES OF ANGLERS AND FISHING EFFORT NORTHEAST AND MIDWEST STATES[7]

STATE	ANGLERS	DAYS OF FISHING	AVERAGE DAYS PER ANGLER
Connecticut	342,000	4,705,000	14
Illinois	1,044,000	13,343,000	13
Maine	341,000	3,873,000	11
Massachusetts	532,000	8,367,000	16
Michigan	1,744,000	28,177,000	16
Minnesota	1,562,000	21,702,000	14
New Hampshire	228,000	4,370,000	19
New Jersey	766,000	9,454,000	12
New York	1,882,000	29,874,000	16
Rhode Island	175,000	2,080,000	12
Vermont	207,000	2,215,000	11
Wisconsin	1,247,000	21,284,000	17
Total	10,070,000	149,444,000	15

Source: USFWS and U.S. Census Bureau (2018)

Lost Value for Recreational Fishing

Several studies estimate the decline in economic value for recreational fishing trips due to the presence of FCAs. Exhibit 4 summarizes the estimated decline in value per trip to a site with an FCA for selected studies. These studies use a well-accepted method—random utility site choice models—and the results can be standardized for comparison (see footnote to Exhibit 4). In site choice models, anglers are assumed to choose sites that maximize their utility (i.e., the value gained). The utility of a site is a function of the cost to access the site (e.g., travel cost) and other site attributes, such as expected catch rates, species available and the presence and severity of FCAs. All else equal, anglers get more utility from sites without FCAs. The model can be used to estimate the decline in value due to the presence of an FCA.

While the locations, methods, and valuation scenarios (i.e., type of affected species, number of sites) vary across these studies, the key takeaways are two-fold: 1) FCAs reduce recreational fishing values; and 2) the decline in value increases with the restrictiveness of the advisory (e.g., the lost value associated with a *Do Not Eat* FCA is greater than the loss associated with an *Eat No More Than One Meal Per Week* FCA).

[7] Note that, across these 12 states, approximately 68 percent of angling participants take part in freshwater fishing, and freshwater fishing accounts for 81 percent of all angling trips.

EXHIBIT 4. SELECTED ESTIMATES OF LOST VALUES ASSOCIATED WITH FCAS[A]

STUDY	LOCATION	LOST VALUE PER FISHING DAY AT SITE WITH A FCA (2019$)
Montgomery and Needelman (1997)	New York	Mixture of "Eat no more than one meal per month" and "Do not eat" FCAs: $34.34
Jakus *et al.* (1997)	Tennessee	Mixture of "Limited" and "Do not eat" FCAs: $25.49
Jakus *et al*. (1998)	Tennessee	Mixture of "Limited" and "Do not eat" FCAs: $24.14
MacNair and Desvousges (2007)	Lower Fox River/ Green Bay	"Limited" FCA: $3.37 "Do not eat" FCA: $11.56
Morey and Breffle (2006)	Lower Fox River/ Green Bay	Mixture of "Unlimited " and "Eat no more than one meal per week" FCAs: $4.04 Mixture of "Eat no more than one meal per month" and "Do not eat" FCAs: $33.78

Notes:

A. The lost values in this table are standardized by dividing the coefficient associated with FCAs by the coefficient associated with the travel cost variable. This standardization provides an estimate of the lost value conditional on choosing a site with a FCA. We refer to this estimate as the lost value per fishing day at a site with a FCA to distinguish it from the lost value per fishing day at any site. Without this adjustment, the lost values are not comparable, as they are affected by the relative importance of the sites that have advisories and by researchers' choices regarding the set of fishing trips to include in the model.

In extreme cases, contamination in fish can result in regulatory closures to recreational fishing (e.g., upper Hudson River from 1976-1994). In most cases, however, contamination results in the issuance of FCAs and anglers are able to continue accessing a contaminated waterbody if they wish. Since sites are not usually closed due to contamination in fish, anglers tend to lose a fraction of their total trip value rather than the entire trip value.

Exhibit 5 presents estimates of total trip values for recreational fishing to contextualize the estimates in Exhibit 4.[8] These estimates are derived from data generated by U.S. federal government agencies, and are broadly applied to a range of analyses used to support policy evaluations and environmental damage assessments. Combining the user day estimates from Exhibit 3 with the value per day estimates from Exhibit 5 yields an estimate in the billions of dollars (regardless of which value(s) is applied).

[8] To the extent that the reported estimates of trip values are for sites that have mercury advisories, either site specific or statewide, the value of these trips may be even greater.

For example, if we assume that the average fishing trip creates a value of $50 to the participant, the estimated economic welfare value of recreational fishing in the 12 states would be approximately $7.5 billion. This represents the full value of fishing across the 12 states that would be realized absent the effects of FCAs (see Exhibit 4). While we do not have information to precisely account for the effects of the MATS Rule on FCAs, and therefore on recreational fishing trip values, we consider the potential for the Rule to generate recreational fishing benefits on the order of $1 billion. Specifically, if the MATS Rule improves the value per recreational fishing trip by $6.70, the aggregate value of recreational fishing across the 12 states would be increased by approximately $1 billion. Given the effects of FCAs on the value of recreational fishing trips described in Exhibit 4 (ranging up to a reduction in $34 per trip), we find that it is reasonable that the benefits of the MATS Rule could easily be $6.70 per trip or greater. Thus, we expect that the MATS Rule results in recreational fishing benefits of $1 billion or more annually.

EXHIBIT 5. SELECTED STUDIES WITH ESTIMATES OF VALUE PER FISHING DAY

STUDY	SUMMARY	VALUE PER USER DAY (2019$)
Rosenberger (2016)	The Recreation Use Values Database (RUVD) summarizes literature on the value of outdoor recreation on public lands. It is the result of seven literature reviews dating back to 1984. The most recent review, sponsored by the USDA Forest Service, was completed in 2016 and contains nearly 3,200 value estimates in per person per activity day units. These estimates are based on over 400 studies of recreation activities in the U.S. and Canada from 1958 to 2015. The database provides value estimates for different activities by census region.	Northeastern U.S. Census Region, freshwater fishing: $83.81 Northeastern U.S. Census Region, saltwater fishing: $86.22 Midwestern U.S. Census Region, freshwater fishing: $50.25
USFWS (2016)	The addendum to the 2011 National Survey of Fishing Hunting and Wildlife-Associated Recreation contains economic values per fishing day by state for bass, trout, or walleye. The survey is conducted every five years by the US Census Bureau and sponsored by the United States Fish and Wildlife Service (USFWS). The 2016 survey did not contain these estimates due to budget constraints.	*Bass* Illinois: $51.58 Massachusetts: $31.40 Rhode Island: $15.70 *Trout* Connecticut: $33.64 Maine: $43.73 New Hampshire: $48.22 New Jersey: $21.31 New York: $65.04 Vermont: $30.28 *Walleye* Michigan: $16.82 Minnesota: $63.92 Wisconsin: $35.88

Lost Regional Economic Activity Associated with Recreational Fishing

While the preceding sections summarize impacts to recreational anglers themselves in the form of lost economic value, there are also negative consequences for regional economic activity when anglers take fewer trips or spend less on the trips they take due to FCAs (e.g., shorter trips). Expenditures on recreational fishing provide sales for businesses (e.g., bait shops, gear outfitters, gas stations), and in turn, these businesses make purchases from other firms in the region to support their operations. Furthermore, employees of these firms make additional purchases with their wages. The summation of these effects represents the total economic contribution of recreational activities to a region, which can be measured in terms of jobs and income, though other measures may be used. Estimates of the regional economic importance of the recreational fishing sector in select states is presented in the next section.

COMMERCIAL FISHING

As noted above, consumers have a range of sources of information on the risks posed by consuming mercury in fish and shellfish purchased in markets. While studies have not been published that estimate the change in demand for seafood products (or the price of these products), we would expect that efforts by some consumers to (1) limit the quantity of fish consumed, and/or (2) to substitute away from certain species of fish will impact both the quantity of fish demanded and the price obtained by this industry for some products. As discussed in the next section, landings of commercial fish and shellfish generate over $1.6 billion dollars in sales in the 12 states considered in this analysis. As such, even modest changes in market demand could have a significant impact on the income of harvesters and processors, with subsequent impacts on the economies of the 12 states considered in this report.

THE IMPORTANCE OF RECREATIONAL FISHING AND COMMERCIAL FISH AND SHELLFISH HARVEST AND PROCESSING IN THE NORTHEAST AND MIDWEST

To understand the potential benefits of reductions in mercury levels in fish and shellfish, we consider the regional economic importance of both recreational fishing behavior and commercial fish harvest and processing. Specifically, this analysis applies input-output multipliers along with publicly available data on recreational angling expenditures and commercial landings to evaluate the regional economic impacts associated with recreational fishing and commercial harvest in select states.

INPUT-OUTPUT MULTIPLIERS

The Regional Input-Output Modeling System (RIMS II or "RIMS") applies a standard input-output modeling approach to analyze the economic impacts or multiplier effects associated with a change in demand within one or more sectors of the economy.[9] Developed by the U.S. Bureau of Economic Analysis, RIMS uses data on national input-output accounts to model the relationships and spending patterns between different industries. Based on these relationships, RIMS provides sector-specific and geographic-specific multipliers that evaluate how a change in economic activity (i.e., spending or demand) in one sector results in economic activity in other sectors within a geographic region (U.S. BEA 2013).

The RIMS multipliers translate changes in economic activity into economic impacts across four metrics: employment, earnings, value added, and output.

- **Employment**: This reflects a mix of full-time and part-time job-years (defined as one job lasting one year) that result from employment demand created by spending activity.
- **Earnings**: This captures all employment-related income received as part of the employment demand, including employee compensation and proprietor income.
- **Value Added**: This reflects the total value of all output or production, minus the cost of intermediate outputs (i.e., Gross Domestic Product).
- **Output**: This reflects the total value of all output or production, including the costs of intermediate and final outputs (i.e., sales).

This analysis applied RIMS Type II multipliers, which incorporate direct, indirect, and induced effects:

- **Direct Effects**: These are production changes that directly result from an activity or policy. In this analysis, the direct effects are equal to the recreational angling expenditures or commercial fish landings, which we allocate to appropriate economic sectors.
- **Indirect Effects**: The multiplier effects that result from changes in the output of industries that supply goods and services to those industries that are directly affected (i.e., impacts on the factors of production for the directly affected sectors).
- **Induced Effects**: Changes in household consumption arising from changes in employment and associated income that result from direct and indirect effects.

To understand these effects, consider an example where recreational anglers buy additional equipment from a local bait shop (direct effects). That bait shop may in turn increase its purchases of supplies from other businesses in the region to support its

[9] To conduct the input-output modeling, this analysis used state-specific RIMS Type II multipliers from the RIMS 2016 dataset, which was the most current version of these data that are publicly available.

operations (indirect effects). Employees benefiting from these increases in spending may then spend more themselves (induced effects).

RECREATIONAL FISHING

To analyze the regional economic impacts associated with recreational fishing, this analysis gathered recreational angling expenditure data from state-specific reports published as part of the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (USFWS and U.S. Census Bureau 2018).[10] Exhibit 6 summarizes the annual recreational fishing expenditure data by state for trip-related, equipment-related, and total spending, as reported in the state-specific reports. All expenditure estimates have been converted to 2019 dollars using the Consumer Price Index.

EXHIBIT 6. ESTIMATES OF ANNUAL RECREATIONAL FISHING EXPENDITURES BY STATE (2019$)[11]

STATE	ANGLERS	ANNUAL TRIP-RELATED EXPENDITURES	ANNUAL EQUIPMENT-RELATED EXPENDITURES	ANNUAL TOTAL EXPENDITURES
Connecticut	342,000	$290,070,461	$199,384,964	$489,455,425
Illinois	1,044,000	$417,561,021	$673,245,251	$1,090,806,272
Massachusetts	532,000	$284,501,650	$226,181,643	$510,683,293
Maine	341,000	$240,746,226	$176,218,217	$416,964,443
Michigan	1,744,000	$1,225,379,517	$1,496,351,625	$2,721,731,141
Minnesota	1,562,000	$1,036,804,729	$1,670,513,217	$2,707,317,946
New Hampshire	228,000	$169,765,753	$64,070,482	$233,836,235
New Jersey	766,000	$546,091,107	$710,127,691	$1,256,218,798
New York	1,882,000	$1,186,333,921	$1,014,431,925	$2,200,765,845
Rhode Island	175,000	$94,123,671	$51,708,305	$145,831,976
Vermont	207,000	$101,202,991	$46,054,269	$147,257,259.99
Wisconsin	1,247,000	$681,205,982	$909,584,424	$1,590,790,406
Total	10,070,000	$6,273,787,028	$7,237,872,012	$13,511,659,041

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[10] The 2011 report is the latest version to report state-specific values.

[11] The regional economic analysis in this report relies on recreational angling expenditure estimates broken out into detailed line items for trip-related, equipment-related, and other expenses (e.g., food, lodging, boating costs, artificial lures and flies). These reported disaggregated estimates by line item do not always sum to the total expenditure estimates for each state, as reported in Exhibit 6. For example, the detailed expenditure line items for Connecticut sum to 83 percent of the total recreational angling expenditures estimated for the state (91 percent for Illinois and New Hampshire; 92 percent for Vermont; 99 percent for Wisconsin; and approximately 100 percent for all other states). To the extent that the detailed expenditure data do not sum to the total recreational angling expenditure estimates for a state, this analysis may underestimate the regional economic impacts associated with recreational angling in that state.

In the appendix of each state-specific report, these total annual trip-related and equipment-related expenditures are broken down into more detailed expenditure line items. Trip-related spending categories include line items such as food, lodging, and transportation, while equipment-related categories include line items such as "reels, rods, and rod-making components" and "artificial lures and flies." This analysis mapped each of these detailed expenditure line items to corresponding RIMS sectors, which included industries defined as "food services and drinking places," "accommodations," and "other retail."

The analysis then applied state-specific and sector-specific RIMS multipliers to the corresponding state-by-state total spending amounts for each RIMS sector. These RIMS multipliers translate the expenditure amounts into estimates of regional economic impacts on employment demand, value added, and output.

Exhibit 7 summarizes the state-by-state results of this analysis. These regional economic impact estimates for recreational angling include direct, indirect, and induced effects.

EXHIBIT 7. ANNUAL REGIONAL ECONOMIC IMPACTS OF RECREATIONAL FISHING EXPENDITURES BY STATE (2019$)

STATE	EMPLOYMENT (JOBS)	EARNINGS ($)	VALUE ADDED ($)	OUTPUT ($)
Connecticut	6,666	$228,243,642	$460,834,368	$748,478,095
Illinois	19,983	$665,317,305	$1,305,284,266	$2,164,735,554
Massachusetts	8,842	$292,655,175	$593,491,314	$968,345,102
Maine	8,989	$239,954,740	$453,171,787	$739,109,734
Michigan	59,161	$1,697,413,376	$3,178,958,350	$5,240,046,989
Minnesota	55,065	$1,687,013,209	$3,239,786,409	$5,369,380,086
New Hampshire	3,538	$111,389,124	$230,329,220	$374,447,756
New Jersey	22,194	$754,204,825	$1,560,657,028	$2,557,479,074
New York	35,359	$1,196,860,993	$2,524,234,433	$4,105,442,367
Rhode Island	2,249	$71,039,141	$154,530,617	$251,997,610
Vermont	2,519	$68,381,808	$135,742,775	$222,127,681
Wisconsin	34,336	$944,406,087	$1,767,276,300	$2,924,547,680
Total	258,902	$7,956,879,425	$15,604,296,867	$25,666,137,726

The results suggest that the $13.5 billion in total annual recreational fishing expenditures across these 12 states generate total regional economic impacts of 258,902 full-time and part-time jobs, $8.0 billion in earnings, $15.6 billion in value added, and $25.7 billion in output (2019 dollars)

COMMERCIAL FISHING

To analyze the regional economic impacts associated with commercial fishing, this analysis gathered commercial seafood landings data published by the NOAA Fisheries, Fisheries Statistics Division (NOAA 2019). This NOAA division collects and publishes commercial landings data on a state-by-state basis, and has separate databases for ocean landings and Midwest landings.[12] We collected the most recent annual landings data from both databases, which consisted of 2017 estimates for ocean landings and 2016 estimates for Midwest landings. The estimated landings and values for Vermont are based on a white paper focused on the scope and value of commercial fish harvest and sales in Vermont.[13] Exhibit 8 summarizes the combined annual commercial landings by state in terms of whole weight (pounds) and dollar value. The dollar value estimates have been converted to 2019 dollars using the Consumer Price Index.

EXHIBIT 8. ESTIMATES OF ANNUAL COMMERCIAL FISH AND SHELLFISH LANDINGS BY STATE (2019$)

STATE	WHOLE WEIGHT (POUNDS)	DOLLAR VALUE ($)
Connecticut	10,118,122	$14,116,116
Illinois	No Data	No Data
Massachusetts	242,136,690	$622,841,959
Maine	208,677,144	$526,176,214
Michigan	6,200,910	$8,561,092
Minnesota	244,714	$225,037
New Hampshire	10,621,078	$36,028,922
New Jersey	198,601,927	$196,087,550
New York	24,904,141	$49,555,181
Rhode Island	84,107,764	$103,697,265
Vermont	459,432	$966,991
Wisconsin	2,670,112	$3,167,164
Total	788,742,034	$1,561,423,491

[12] For the state-by-state breakdown, the "landings data do not indicate the physical location of harvest but the location at which the landings either first crossed the dock or were reported from" (NOAA 2019).

[13] The estimates for Vermont account for 2012 landings and estimated value from January through September and, therefore, likely underestimate the total value of landings for that year. The values are adjusted to 2019 dollars using the Consumer Price Index. The white paper of landings and values in Vermont collected by the Vermont Department of Fish and Wildlife was provided to IEc on April 12, 2019.

This analysis mapped the dollar value of commercial fish and shellfish landings (i.e., total sales) to the corresponding RIMS sector of "fishing, hunting and trapping."[14] State-specific RIMS multipliers for this industry were then applied to the state-by-state annual commercial landings values. These RIMS multipliers translate the dollar value of landings into estimates of regional economic impacts on employment demand, value added, and output.

Exhibit 9 summarizes the state-by-state results of this analysis. These regional economic impact estimates for commercial fishing include direct, indirect, and induced effects.

The results suggest that the $1.6 billion in annual commercial fish landings for these 12 states generate total regional economic impacts of 17,794 full-time and part-time jobs, $700 million in earnings, $1.6 billion in value added, and $2.4 billion in output.

EXHIBIT 9. ANNUAL REGIONAL ECONOMIC IMPACTS OF COMMERCIAL FISH LANDINGS BY STATE

STATE	EMPLOYMENT (JOBS)	EARNINGS ($)	VALUE ADDED ($)	OUTPUT ($)
Connecticut	151	$6,415,775	$14,449,256	$22,320,402
Illinois	No Data	No Data	No Data	No Data
Massachusetts	6,495	$269,752,852	$627,762,410	$961,294,279
Maine	6,520	$250,617,731	$533,700,534	$823,991,952
Michigan	164	$4,288,251	$9,079,038	$14,303,016
Minnesota	4	$114,589	$244,885	$393,387
New Hampshire	No Data	No Data	No Data	$36,028,922
New Jersey	2,334	$98,710,472	$219,500,403	$347,388,703
New York	911	$22,047,100	$50,189,488	$77,206,972
Rhode Island	1,155	$45,906,779	$104,153,533	$160,544,105
Vermont	No Data	No Data	No Data	$966,991
Wisconsin	60	$1,536,708	$3,273,898	$5,151,392
Total	17,794	$699,390,257	$1,562,353,445	$2,449,590,123

RECREATIONAL AND COMMERCIAL FISHING

Recreational and commercial fishing activities in these 12 states generate significant regional economic activity. This analysis finds that the $12.0 billion in annual recreational fishing expenditures and the $1.6 billion in annual commercial fish landings for these 12 states result in a regional economic contribution of 276,696 full-time and part-time jobs, $8.7 billion in earnings, $17.2 billion in value added, and $28.1 billion in output. At this scale of economic activity, even small shifts in recreational fishing

[14] The primary economic activity within this sector is fish harvesting.

behavior or consumer purchasing as a result of elevated mercury concentrations could result in substantial economic impacts to related economic industries at the state or regional level. For example, if recreational anglers reduce their equipment- and trip-related expenditures by ten percent per year across the 12 states, the economic impact on value-added (equivalent to a GDP reduction) could be on the order of *$1.5 billion annually*.

ASSUMPTIONS, LIMITATIONS, AND CAVEATS

The following assumptions, limitations, and caveats apply to interpreting the results of this analysis:

- This analysis applied state-specific RIMS multipliers. As a result, it does not capture indirect and induced economic impacts that may have occurred outside each state (for example, if certain indirect or induced economic activity "leaked" beyond a state into neighboring states). To the extent that any economic activity produced by recreational or commercial fishing expenditures resulted in increases in regional economic activity outside each state, the output results may be understated.
- This analysis assumed that all sales and business activity related to commercial landings occurred within the state where landings were reported. In practice, commercial fishing businesses may operate in those states but be based in other states. For example, the analysis estimates that New Hampshire had approximately $36.0 million in commercial landings, but the RIMS multipliers suggest that did not generate any jobs, earnings, or value added for the state. Similarly, data from Vermont identify approximately $1 million in commercial landings, although the RIMS multipliers do not identify any associated indirect and induced impacts for the state. This may be because these economic impacts accrued to businesses that operate in New Hampshire and Vermont but are based in other states or that the U.S. Bureau of Economic Analysis (BEA) did not have sufficient industry-specific data to estimate the multiplier effects. In either case, the economic impact results reported may be understated for New Hampshire and Vermont.

IMPACTS OF FCAS TO HOUSING VALUES

Recent evidence demonstrates that mercury-based FCAs have a negative impact on property values. Tang *et al*. (2018) used the hedonic pricing method to estimate that New York State property values within one mile of an FCA-designated lake due to mercury decrease by an average of six to seven percent. The method uses property transaction data and information about various attributes of properties (i.e., size of house, quality of schools, proximity to open space for recreation and urban centers for work) to estimate a model that can be used to deduce the contribution of a given attribute to the sales price. Numerous published studies have estimated the impact of various measures of environmental quality on property values, though this is the only study we are aware of that estimates the impact of mercury-based FCAs on nearby property values. Since property values should capitalize the value of recreational opportunities, at least for occupants of the property, the estimates presented in Tang *et al*. (2018) should not be considered unique from the estimates of lost value to recreationists presented in a previous section, but as additional evidence that elevated mercury levels in fish have broad economic consequences.

WELL ACCEPTED AND WIDELY USED METHODS EXIST THAT EPA COULD USE TO QUANTIFY THE ECONOMIC BENEFITS ASSOCIATED WITH THE MATS RULE ON RECREATIONAL AND COMMERCIAL FISHERIES

As described above, there is ample evidence of the contribution of coal-fired EGUs to mercury levels in fish and shellfish. Elevated mercury levels lead to changes in consumer and recreator behavior, informed by state and federal health advisories and other information provided by non-governmental entities. These behavioral changes generate losses in consumer surplus and adverse impacts on regional economic activity.

In both EPA's 2011 Regulatory Impact Analysis (RIA) for the MATS Rule (U.S. EPA 2011) and the current proposed rule (U.S. EPA 2019) there was no attempt to quantify or monetize the social welfare or regional economic benefits resulting from changes in recreator or consumer behavior due to reductions in mercury emissions from the MATS Rule. Conversely, with the proposed rule, EPA has made no effort to account for the costs to states associated with changes in recreator and consumer behavior should EPA's reversal of its appropriate and necessary finding ultimately lead to abolishment of the standards (emissions limits) themselves, and a subsequent increase in mercury fish tissue concentrations.

Recreational and subsistence fishing as well as commercial fish harvest and processing play a substantial role in the economies and cultures of the Northeast and the Midwest. As such, even modest changes in mercury levels could have significant economic implications. Widely utilized and well accepted methods are available to place monetary values on the reduction in mercury concentrations in fish and shellfish that have and are expected to result from the MATS Rule. These are the same economic methods frequently applied by federal agencies bringing damage claims when acting as trustee for natural resources under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the1990 Oil Pollution Act, as well as the same methods widely used in the context of benefit analyses conducted under 316(b) of the Clean Water Act. Application of these methods to the MATS Rule would provide a more complete and transparent understanding of the actual benefits of the MATS Rule, and as such an understanding of the social and regional economic cost that would result from removing these requirements.

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APPENDIX A:

EXAMPLES OF GENERAL STATEWIDE SAFE FISH GUIDELINES

HEALTH ALERT

The Vermont Department of Health recommends that people limit eating some fish caught in Vermont waters.

These advisories are based on tests of fish caught in Vermont waters and scientific information about the harmful effects of mercury and, in the case of large lake trout in Lake Champlain and all fish in the Hoosic River, PCBs (poly-chlorinated biphenyls).

You can mix and match fish (you catch or buy) with the same limits, but once you meet the lowest limit eat no more fish that month. Do not eat the monthly limit within a single week.

Store bought fresh and canned fish—including tuna—have mercury levels that are about the same as many Vermont-caught fish. Add in store bought fish when you decide how many fish meals to eat each month.

One fish meal = 8 ounces uncooked fish

For more information call
1-800-439-8550
healthvermont.gov

VERMONT
DEPARTMENT OF HEALTH

	Women of childbearing age and children age 6 and under	Everyone else
GENERAL ADVISORY:		
Brown Bullhead Pumpkinseed	No more than 5 meals/month	No Restrictions
Walleye	0 Meals	No more than 1 meal/month
American Eel Chain Pickerel Lake Trout Smallmouth Bass	No more than 1 meal/month	No more than 3 meals/month
Largemouth Bass Northern Pike Yellow Perch (10 inches and larger)	No more than 2 meals/month	No more than 6 meals/month
Brook Trout Brown Trout Rainbow Trout White Perch Yellow Perch (smaller than 10 inches)	No more than 3-4 meals/month	No Restrictions
All Other Fish	No more than 2-3 meals/month	No more than 9 meals/month
SPECIAL ADVISORIES:		
Lake Carmi - Walleye	No more than 4 meals/month	No Restrictions
Lake Champlain Lake Trout (larger than 25 inches)	0 meals (includes all children under 15)	No more than 1 meal/month
Smallmouth Bass (19 inches and larger)	0 meals	No more than 1 meal/month
Yellow Perch (smaller than 10 inches)	No more than 5 meals/month	No Restrictions
Shelburne Pond Yellow Perch (smaller than 10 inches)	No more than 5 meals/month	No Restrictions
Hoosic River - All Fish	0 meals	0 meals
Deerfield Chain (Grout Pond, Somerset Reservoir, Harriman Reservoir, Sherman Reservoir, and Searsburg Reservoir)		
Brook Trout Brown Bullhead	No more than 5 meals/month	No Restrictions
Brown Trout (14 inches and smaller) Rainbow Smelt Rainbow Trout Rock Bass Yellow Perch	No more than 1 meal/month	No more than 3 meals/month
Brown Trout (larger than 14 inches) All Other Fish	0 meals	No more than 1 meal/month
15 Mile Falls Chain (Comerford Reservoir and Moore Reservoir)		
White Sucker	No more than 1 meal/month	No more than 3 meals/month
All Fish	0 meals	No more than 2 meals/month
15 Mile Falls Chain (McIndoes Reservoir)		
Yellow Perch	No more than 2 meals/month	No more than 6 meals/month
All Other Fish	No more than 1 meal/month	No more than 3 meals/month

v.May 2013

Statewide Safe Fish Guidelines

Michigan Department of Community Health

Use the Statewide Safe Fish Guidelines ONLY if:

STOP

- **your lake or river is not listed in the *Eat Safe Fish Guide*, OR**
- **your lake or river is listed in the *Eat Safe Fish Guide*, but the fish species is not listed.**

- Michigan is lucky to have over 11,000 lakes, rivers, and streams. Because of that huge number, it is not possible to test every fish species from every lake, river, or stream in the state.
- These general guidelines are based on the typical amount of chemicals found in fish filets tested from around the state. Some fish may be higher or lower.
- If any of these fish are listed in the *Eat Safe Fish Guide* for the lake or river you are fishing in, use those guidelines instead of the Statewide Safe Fish Guidelines. The *MI Servings* recommendation will be more exact for that lake or river because those filets have been tested.
- These general guidelines can be used for lakes, rivers, and fish species not included in the *Eat Safe Fish Guide.*

To get a free copy of the *Eat Safe Fish Guide*, visit www.michigan.gov/eatsafefish or call 1-800-648-6942.

eat safe fish

Michigan Department of Community Health

MDCH

Type of Fish	Chemical of Concern	Size of Fish (length in inches)	MI Servings per Month*
Black Crappie	Mercury	Any Size	4
Bluegill	Mercury	Any Size	8
Carp	PCBs	Any Size	2
Catfish	PCBs & Mercury	Any Size	4
Largemouth Bass	Mercury	Under 18"	2
		Over 18"	1
Muskellunge (Muskie)	Mercury	Any Size	1
Northern Pike	Mercury	Under 30"	2
		Over 30"	1
Rock Bass	Mercury	Any Size	4
Smallmouth Bass	Mercury	Under 18"	2
		Over 18"	1
Suckers	Mercury	Any Size	8
Sunfish	Mercury	Any Size	8
Walleye	Mercury	Under 20"	2
		Over 20"	1
White Crappie	Mercury	Any Size	4
Yellow Perch	Mercury	Any Size	4

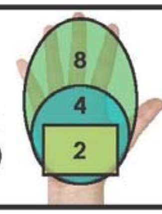
See page 2 to learn about *MI Servings

What is *MI Serving*?

You can use the information below to find out how much fish is in a *MI Serving* ("my serving") for you. If you're planning on eating more than 1 *MI Serving* of fish at a single meal, aim to eat fish that are listed as 2-8 *MI Servings* per month to be sure you're within the safe range.

My Michigan, *MI Serving* Size

- ☑ 8 ounces of fish = size of an adult's hand (large oval)
- ☑ 4 ounces of fish = size of the palm of an adult's hand (small circle)
- ☑ 2 ounces of fish = size of half a palm of an adult's hand (rectangle)



How much is *MI Serving*?

Weight of Person	*MI Serving* Size
45 pounds	2 ounces
90 pounds	4 ounces
180 pounds	8 ounces

Weigh Less?

For every 20 pounds less than the weight listed in the table, subtract 1 ounce of fish.

For example, a 70 pound child's *MI Serving* size is 3 ounces of fish.
90 pounds - 20 pounds = 70 pounds
4 ounces - 1 ounce = a *MI Serving* size of 3 ounces

Weigh More?

For every 20 pounds more than the weight listed in the table, add 1 ounce of fish.

For example, a 110 pound person's *MI Serving* size is 5 ounces of fish.
90 pounds + 20 pounds = 110 pounds
4 ounces + 1 ounce = a *MI Serving* size of 5 ounces

Are you pregnant? Fish is good for you and your baby! Use your pre-pregnancy weight to find your *MI Serving* size. It is best to avoid eating fish labeled as "Limited" if you're pregnant or breastfeeding.

About the Statewide Safe Fish Guidelines

- The Statewide Safe Fish Guidelines are set to provide safe options for everyone.
- They can be used by children, pregnant or breastfeeding women, and people who have health problems, like cancer, heart disease, or diabetes.
- The Statewide Safe Fish Guidelines can also be used by healthy adults to avoid getting too much of the chemicals in their bodies.
- Chemicals like PCBs and dioxins are linked to cancer, diabetes, and other illnesses.
- Mercury can cause damage to your brain, heart, and nerves.
- MDCH tests only the filet of the fish, and they use science-based calculations to find how much fish is safe to eat. With the Statewide Safe Fish Guidelines and the *Eat Safe Fish Guide*, everyone can now choose safer fish.

Questions? Please visit www.michigan.gov/eatsafefish or call 1-800-648-6942 for more information.

Freshwater Fish Consumption Advisory List

Massachusetts Department of Public Health
Bureau of Environmental Health
(617) 624-5757
November 2018

WATER BODY	TOWN(s)	FISH ADVISORY*	HAZARD*
Aaron River Reservoir	Cohasset, Hingham, Scituate	P1 (all species), P2 (CP, YP), P4	Mercury
Alewife Brook	Arlington, Belmont, Cambridge,Somerville	P1 (C), P3 (C)	PCBs
Ames Pond	Tewksbury	P1 (LMB), P3 (LMB)	Mercury
Ashland Reservoir	Ashland	P1 (all species), P5	Mercury
Ashley Lake	Washington	P1 (YP), P3 (YP)	Mercury
Ashfield Pond	Ashfield	P1 (LMB), P3 (LMB)	Mercury
Ashumet Pond	Mashpee, Falmouth	P1 (LMB), P3 (LMB)	Mercury
Atkins Reservoir	Amherst, Shutesbury	P1 (all species), P5	Mercury
Attitash, Lake	Amesbury, Merrimac	P1 (all species), P2 (LMB), P4	Mercury
Badluck Lake	Douglas	P6	Mercury
Baker Pond	Brewster, Orleans	P1 (YP), P3 (YP)	Mercury
Baldpate Pond	Boxford	P1 (all species), P2 (LMB), P4	Mercury
Ballardvale Impoundment of Shawsheen River	Andover	P1 (LMB & BC), P3 (LMB & BC)	Mercury
Bare Hill Pond	Harvard	P1 (LMB), P3 (LMB)	Mercury
Bearse Pond	Barnstable	P1 (LMB, SMB), P3 (LMB, SMB)	Mercury
Beaver Pond	Bellingham, Milford	P1 (CP, LMB), P3 (CP, LMB)	Mercury
Big Pond	Otis	P1 (all species), P2 (LMB), P4	Mercury
Boon, Lake	Hudson, Stow	P1 (LMB & BC), P3 (LMB & BC)	Mercury
Box Pond	Bellingham, Mendon	P1 (WS), P2 (WS)	DDT
Bracket Reservoir (Framingham Reservoir #2) – See Sudbury River			
Browning Pond	Oakham, Spencer	P1 (LMB, YP), P3 (LMB, YP)	Mercury
Buckley Dunton Lake	Becket	P1 (LMB), P3 (LMB)	Mercury
Buffomville Lake	Charlton, Oxford	P1 (all species), P5	Mercury
Burr's Pond	Seekonk	P1 (LMB), P3 (LMB)	Mercury
Cabot Pond – See Rumford River			
Canton River (between the Neponset River and Neponset Street dam)	Canton	P1 (all species), P2 (AE, WS), P4	PCBs, DDT
Cedar Swamp Pond	Milford	P1 (all species), P5	Mercury
Chadwicks Pond	Boxford, Haverhill	P6	Mercury
Charles River (between the South Natick Dam in Natick and the Museum of Science Dam in Boston/ Cambridge)	Boston, Cambridge, Dedham, Dover, Natick, Needham, Newton, Watertown, Wellesley, Weston, Waltham	P1 (C, LMB), P2 (C), P3 (LMB)	PCBs, Pesticides
Charles River (between the Medway Dam in Franklin and Medway and the South Natick Dam in Natick)	Dover, Franklin, Medfield, Medway, Millis, Natick, Norfolk, Sherborn	P1 (all species), P5	Mercury, Chlordane, DDT
Chebacco Lake	Essex, Hamilton	P1 (LMB), P3 (LMB)	Mercury
Clay Pit Pond	Belmont	P6	Chlordane
Cochato River, Ice Pond and Sylvan Lake	Randolph, Holbrook, Braintree	P1 (all species), P2 (BB & C & AE), P4	Pesticides
Cochichewick, Lake	North Andover	P1 (LMB, SMB), P3 (LMB, SMB)	Mercury
Cochituate, Lake (including Middle, North, South, and Carling Basins)	Framingham, Natick, Wayland	P1 (all species), P2 (AE)	PCBs

* See page 7 for codes.

WATER BODY	TOWN(s)	FISH ADVISORY*	HAZARD*
Concord River (from confluence with Sudbury and Assabet Rivers to the Faulkner Dam in Billerica)	Concord, Carlisle, Bedford, Billerica	P1 (all species), P2 (LMB), P4	Mercury
Connecticut River	Entire length of Massachusetts, including all towns from Northfield through Longmeadow	P1 (all species), P2 (CC & WC & AE & YP)	PCBs
Copicut Reservoir	Dartmouth, Fall River	P6	Mercury
Copicut River	Dartmouth, Fall River	P1 (all species), P2 (AE), P3 (LMB)	PCBs, Mercury
Cornell Pond	Dartmouth	P1 (all species), P2 (AE), P3 (LMB)	PCBs, Mercury
Crystal Lake	Haverhill	P1 (all species), P2 (LMB), P4	Mercury
Damon Pond	Chesterfield, Goshen	P1 (CP, LMB), P3 (CP, LMB)	Mercury
Dennison, Lake	Winchendon	P1 (LMB), P3 (LMB)	Mercury
Dodgeville Pond - See Mechanics Pond			
Drinkwater River/ Indian Head River/North River (Betweeen the Forge Pond Dam in Hanover and Route 3 in Norwell/ Pembroke) and Factory Pond	Hanson, Hanover, Norwell, Pembroke	P6	Mercury
Duck Pond	Wellfleet	P6	Mercury
Dyer Pond	Wellfleet	P6	Mercury
East Brimfield Reservoir	Brimfield, Sturbridge	P1 (all species), P5	Mercury
East Monponsett Pond	Halifax	P1 (LMB), P3 (LMB)	Mercury
Echo Lake	Hopkinton, Milford	P1 (all species), P2 (LMB), P4	Mercury
Factory Pond - See Drinkwater River			
Fall Brook Reservoir	Leominster	P1 (all species), P5	Mercury
Farrar Pond	Lincoln	P1 (BC, CP, LMB), P3 (BC, CP, LMB)	Mercury
Flax Pond	Lynn	P1 (AE, WP), P2 (AE)	DDT, Chlordane
Flint Pond	Tyngsborough	P1 (all species), P2 (LMB), P4	Mercury
Forest Lake	Methuen	P1 (LMB), P3 (LMB)	Mercury
Forge Pond	Littleton, Westford	P1 (LMB), P3 (LMB)	Mercury
Fort Meadow Reservoir	Hudson, Marlborough	P1 (WS), P3 (WS)	Chlordane
Foster Pond	Swampscott	P1 (AE), P2 (AE)	DDT
Fosters Pond	Andover, Wilmington	P1 (all species), P5	Mercury
Freeman Lake – See Newfield Pond			
French River (Between the Hodges Village Dam in Oxford and the North Webster Village Pond Dam in Webster)	Oxford, Webster	P1 (all species), P2 (LMB), P4	Mercury
Fulton Pond - See Rumford River			
Gales Pond	Warwick	P1 (YP), P3 (YP)	Mercury
Garfield, Lake	Monterey	P1 (LMB), P3 (LMB)	Mercury
Gibbs Pond	Nantucket	P1 (all species), P5	Mercury
Goodrich Pond	Pittsfield	P6	PCBs
Great Herring Pond	Bourne, Plymouth	P1 (SMB), P3 (SMB)	Mercury
Great Pond	Truro	P1 (all species), P5	Mercury
Great Pond	Wellfleet	P6	Mercury
Great South Pond	Plymouth	P1 (all species), P5	Mercury
Grove Pond	Ft. Devens, Ayer	P6	Mercury
Haggetts Pond	Andover	P1 (all species), P2 (LMB), P4	Mercury
Hamblin Pond	Barnstable	P1 (SMB), P3 (SMB)	Mercury
Hardwick Pond	Hardwick	P1 (LMB), P3 (LMB)	Mercury
Heard Pond	Wayland	P6	Mercury
Heart Pond	Chelmsford, Westford	P1 (LMB), P3 (LMB)	Mercury
Hickory Hills Lake	Lunenburg	P1 (all species), P5	Mercury

2

WATER BODY	TOWN(s)	FISH ADVISORY*	HAZARD*
Hocomonco Pond	Westborough	P6	PAHs
Holland Pond	Brimfield, Holland, Sturbridge	P1 (all species), P5	Mercury
Hood (or Hoods) Pond	Topsfield, Ipswich	P1 (all species), P2 (LMB, YP), P4	Mercury
Hoosic River (from the channelized section in North Adams to the MA/VT state line)	N. Adams, Williamstown	P6	PCBs
Horn Pond	Woburn	P1 (LMB), P3 (LMB)	DDT
Horseleech Pond	Truro	P1 (LMB), P3 (LMB)	Mercury
Hovey's Pond	Boxford	P1 (all species), P5	Mercury
Housatonic River (See footnote 1)	All towns from Dalton through Sheffield	P6 (also includes frogs and turtles)	PCBs
Ice Pond – See Cochato River			
Indian Head River – See Drinkwater River			
Ipswich River (between the Bostik Findley Dam in Middleton and the Sylvania Dam in Ipswich)	Boxford, Danvers, Hamilton, Ipswich, Middleton, Peabody, Topsfield, Wenham	P1 (all species), P5	Mercury
Johns Pond	Mashpee	P1 (all species), P2 (SMB), P4	Mercury
Johnsons Pond	Groveland, Boxford	P1 (LMB), P3 (LMB)	Mercury
Kenoza Lake	Haverhill	P6	Mercury
Kingman Pond – See Rumford River			
Knops Pond	Groton	P1 (LMB), P3 (LMB)	Mercury
Konkapot River (From the Mill River Dam in New Marlborough to its confluence with the Housatonic River)	Sheffield, New Marlborough	P1 (all species), P5	Mercury
Lakes whose names begin with "Lake" are listed under the second word in their name (so that Lake Pentucket is listed under "Pentucket," etc.)			
Lashaway, Lake	North Brookfield, East Brookfield	P1 (LMB, SMB), P3 (LMB, SMB)	Mercury
Lawrence Pond	Sandwich	P1 (LMB), P3 (LMB)	Mercury
Leverett Pond	Boston, Brookline	P1 (C), P2 (C)	DDT
Lewin Brook Pond	Swansea	P1 (BC, LMB), P3 (BC, LMB)	Mercury
Little Chauncy Pond	Northborough	P1 (BC, LMB), P3 (BC, LMB)	Mercury
Locust Pond	Tyngsborough	P1 (all species), P5	Mercury
Long Pond	Brimfield, Sturbridge	P1 (all species), P5	Mercury
Long Pond	Dracut, Tyngsboro	P1 (all species), P5	Mercury
Long Pond	Rutland	P1 (all species), P5	Mercury
Long Pond	Wellfleet	P6	Mercury
Long Pond (Rochester) – See Snipituit Pond			
Lost Lake	Groton	P1 (LMB), P3 (LMB)	Mercury
Lowe Pond	Boxford	P1 (all species), P2 (LMB), P4	Mercury
Lowell Canals (see footnote 2)	Lowell	P1 (all species), P2 (AE), P4	Mercury, Lead, PCBs, DDT
Lower Mystic Lake	Arlington, Medford	P1 (WS), P2 (WS)	PCBs, DDT
Malden River	Everett, Malden, Medford	P6	PCBs, Chlordane, DDT
Manchaug Pond	Douglas, Sutton	P1 (LMB), P3 (LMB)	Mercury
Martins Pond	North Reading	P1 (LMB & BC & YP), P3 (LMB & BC& YP)	Mercury
Mashpee Pond	Mashpee, Sandwich	P1 (SMB), P3 (SMB)	Mercury
Massapoag Lake	Sharon	P1 (LMB), P3 (LMB)	Mercury
Massapoag Pond	Dunstable, Groton, Tyngsboro	P1 (all species), P5	Mercury

1 Fish taken from feeder streams to the Housatonic River should be trimmed of fatty tissue prior to cooking.
2 For Lowell Canals, the public is advised to consume only the fillet of those species not specifically listed in the advisory.

WATER BODY	TOWN(s)	FISH ADVISORY*	HAZARD*
Mechanics Pond, Dodgeville Pond, and the section of the Ten Mile River that connects them	Attleboro	P1 (WP), P3 (WP)	Chlordane
Merrimack River (from the MA/NH state line to Broadway Dam in Lawrence)	All towns from Tyngsborough through Lawrence	P1 (WS & LMB), P3 (WS & LMB)	Mercury
Miacomet Pond	Nantucket	P1 (all species), P2 (WP), P4	Mercury
Mill Pond	Burlington	P1 (LMB), P3 (LMB)	Mercury
Mill Pond (SuAsCo Reservoir) above GH Nichols Dam	Westborough	P1 (all species), P2 (LMB)	Mercury
Mill River	Hopedale	P1 (all species), P5	PCBs
Millers River and its tributaries (between the confluence with the Otter River in Winchendon and the Connecticut River in Erving/Montague)	Athol, Erving, Montague, Orange, Phillipston, Royalston, Wendell, Winchendon	P1 (all species), P2 (AE, BT), P4	PCBs
Millvale Reservoir	Haverhill	P1 (all species), P2 (LMB)	Mercury
Mirror Lake	Ft. Devens, Harvard	P1 (LMB), P3 (LMB)	Mercury
Monomonac, Lake and the North branch of Millers River (Between the outlet of Lake Monomonac and the inlet of Whitney Pond)	Winchendon	P1 (all species), P5	Mercury
Moores Pond	Warwick	P1 (AE, CP), P3 (AE, CP)	Mercury
Morewood Lake	Pittsfield	P6	PCBs
Mother Brook (between Charles River and Knight Street Dam)	Dedham, Boston	P1 (C, LMB, WS), P3 (C, LMB, WS)	Mercury, DDT
Mother Brook (between the Knight Street Dam and the Neponset River)	Boston	P1 (all species), P2 (AE, WS), P4	PCBs, DDT
Muddy River	Boston, Brookline	P1 (all species), P2 (BB & C & AE), P4	PCBs
Mystic River (between outlet of Lower Mystic Lake and Amelia Earhart Dam)	Arlington, Everett, Medford, Somerville	P6	PCBs, Chlordane, DDT
Nabnasset Pond	Westford	P1 (LMB), P3 (LMB)	Mercury
Neponset River (between the Hollingsworth & Vose Dam in Walpole and the Walter Baker Dam in Boston)	Boston, Canton, Dedham, Milton, Norwood, Sharon, Walpole, Westwood	P1 (all species), P2 (AE, WS), P4	PCBs, DDT
New Bedford Reservoir	Acushnet	P1 (AE, LMB), P3 (AE, LMB)	Mercury, DDT
Newfield Pond (= Freeman Lake)	Chelmsford	P1 (LMB), P3 (LMB)	Mercury
Nippenicket, Lake	Bridgewater, Raynham	P1 (all species), P2 (LMB), P4	Mercury
Noquochoke Lake	Dartmouth	P1 (all species), P2 (LMB & AE), P4	Mercury, PCBs
North River – see Drinkwater River			
Norton Reservoir – See Rumford River			
Nutting Lake	Billerica	P1 (all species), P5	Mercury
Otis Reservoir	Otis, Tolland	P1 (all species), P5	Mercury
Otter River (between the Seaman Paper Dam in Templeton and the confluence with the Millers River in Winchendon)	Templeton, Winchendon	P1 (all species), P2 (BB & WS), P4	PCBs
Pelham Lake	Rowe	P1 (LMB), P3 (LMB)	Mercury
Pentucket Pond	Georgetown	P1 (all species), P2 (LMB & BC), P4	Mercury
Pentucket, Lake	Haverhill	P6	Mercury
Pepperell Pond	Pepperell, Groton	P1 (all species), P2 (LMB), P4	Mercury
Peters Pond	Sandwich	P1 (all species), P5	Mercury
Pettee Pond	Walpole, Westwood	P1 (LMB), P3 (LMB)	Mercury
Plainfield Pond	Plainfield	P1 (LMB), P3 (LMB)	Mercury
Pleasant Pond	Hamilton, Wenham	P1 (LMB), P3 (LMB)	Mercury
Plowshop Pond	Ft. Devens, Ayer	P6	Mercury
Pomps Pond	Andover	P1 (all species), P2 (LMB), P4	Mercury

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WATER BODY	TOWN(s)	FISH ADVISORY*	HAZARD*
Ponkapoag Pond	Canton, Randolph	P1 (all species), P5	Mercury
Pontoosuc Lake	Pittsfield, Lanesborough	P1 (LMB), P3 (LMB)	Mercury
Populatic Pond	Franklin, Medway, Norfolk	P1 (all species), P5	Mercury, Chlordane, DDT
Powder Mill Pond	Barre	P1 (all species), P5	Mercury
Puffer Pond	Ft. Devens Sudbury Training Annex, Maynard	P6	Mercury
Quabbin & Wachusett Reservoirs (See footnote 3)	New Salem, Shutesbury, Petersham, Hardwick, Ware, Pelham, Belchertown, Boylston, West Boylston, Sterling, Clinton	See footnote 3	Mercury
Quaboag Pond	E. Brookfield, Brookfield	P1 (all species), P2 (LMB), P4	Mercury
Quannapowitt, Lake	Wakefield	P1 (C), P3 (C)	DDT
Quinebaug River (from dam at Hamilton Reservoir through East Brimfield Reservoir/Long Pond, including Holland Pond)	Brimfield, Holland, Sturbridge	P1 (all species), P5	Mercury
Red Bridge Pond	Wilbraham	P1 (BC, LMB), P3 (BC, LMB)	Mercury
Reservoir #6	Sutton	P1 (all species), P5	Mercury
Reservoir Pond	Canton	P1 (LMB, WP), P3 (LMB, WP)	Mercury
Rice City Pond	Northbridge, Uxbridge	P1 (all species), P2 (C, WS), P4	PCBs, DDT
Riverdale Pond	Northbridge	P1 (all species), P5	PCBs
Rock Pond	Georgetown	P1 (all species), P2 (LMB), P4	Mercury
Rohunta, Lake (Middle, North, and South Basins)	Orange, Athol, New Salem	P1 (all species), P5	Mercury
Rolling Dam Impoundment	Blackstone	P1 (all species), P2 (C, WS), P4	PCBs, DDT
Round Pond East	Truro	P1 (all species), P2 (LMB), P4	Mercury
Round Pond West	Truro	P1 (YP), P3 (YP)	Mercury
Rumford River (from Glue Factory Pond Dam; Fulton, Kingman, & Cabot ponds; Norton reservoir)	Foxborough, Mansfield, Norton	P6	Dioxin, Pesticides
Ryder Pond	Truro	P6	Mercury
Saltonstall, Lake	Haverhill	P1 (LMB), P3 (LMB)	Mercury
Sampsons Pond	Carver	P1 (BB, WP), P3 (BB, WP)	Mercury, DDT
Sargent Pond	Leicester	P1 (LMB), P3 (LMB)	Mercury
Sawdy Pond	Fall River, Westport	P1 (LMB), P3 (LMB)	Mercury
Shawsheen River - See Ballardvale Impoundment			
Sheep Pond	Brewster	P1 (all species), P5	Mercury
Sherman Reservoir	Rowe, Monroe	P1 (all species), P2 (YP), P4	Mercury
Shirley Lake	Lunenburg	P1 (all species), P5	Mercury
Silver Lake	Pittsfield	P6	PCBs
Silver Lake	Wilmington	P1 (LMB, YB), P3 (LMB, YB)	Mercury, DDT
Slough Pond	Truro	P1 (all species), P2 (LMB), P4	Mercury
Snake Pond	Sandwich	P1 (all species), P2 (SMB), P4	Mercury
Snipituit Pond and Long Pond	Rochester	P1 (BC & LMB), P3 (BC & LMB)	Mercury
Snow Pond	Truro	P1 (LMB), P3 (LMB)	Mercury

3 Children younger than 12 years, pregnant women, and nursing women should not consume fish except for lake trout less than 24 inches long and salmon. All other people should not eat smallmouth bass, largemouth bass, or lake trout greater than 24 inches long; may eat unlimited amounts of salmon and lake trout less than 24 inches long; and should limit consumption of all other Quabbin and Wachusett Reservoir fish species to one five-ounce meal per week.

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WATER BODY	TOWN(s)	FISH ADVISORY*	HAZARD*
South Pond (= Quacumquasit Pond)	Sturbridge, Brookfield, E. Brookfield	P1 (all species), P5	Mercury
Spectacle Pond	Sandwich	P1 (all species), P5	Mercury
Spectacle Pond	Wellfleet	P1 (YP), P3 (YP)	Mercury
Spicket River - See Stevens Pond & Spicket River			
Spy Pond	Arlington	P1 (C), P2 (C)	DDT, Chlordane
Stern Reservoir (Framingham Reservoir #1) – See Sudbury River			
Stevens Pond & Spicket River (from Stevens Pond to Music Hall Dam in Methuen)	Lawrence, Methuen	P1 (C, LMB, WS), P3 (C, LMB, WS)	Mercury, DDT
Stevens Pond	North Andover	P1 (LMB), P3 (LMB)	Mercury
Stockbridge Bowl	Stockbridge	P1 (LMB), P3 (LMB)	Mercury
Sudbury Reservoir	Marlborough, Southborough	P1 (all species), P2 (Bass)	Mercury
Sudbury River (from Ashland to its confluence with the Assabet and Concord Rivers), Stern Reservoir, and Bracket Reservoir	All towns from Ashland through Concord	P6	Mercury
Sylvan Lake – See Cochato River			
Ten Mile River – see Mechanics Pond			
Texas Pond (= Thayer Pond)	Oxford	P1 (LMB), P3 (LMB)	Mercury
Thayer Pond – see Texas Pond			
Tom Nevers Pond	Nantucket	P1 (all species), P5	Mercury
Turner Pond	Dartmouth, New Bedford	P1 (all species), P5	Mercury
Upper Naukeag Lake	Ashburnham	P1 (all species), P2 (LMB, SMB), P4	Mercury
Upper Reservoir	Westminster	P1 (all species), P2 (LMB), P4	Mercury
Wachusett Lake	Princeton, Westminster	P1 (LMB), P3 (LMB)	Mercury
Wachusett Reservoir – See Quabbin Reservoir			
Waite Pond	Leicester	P1 (all species), P2 (CP), P4	Mercury
Wakeby Pond	Mashpee, Sandwich	P1 (SMB), P3 (SMB)	Mercury
Walden Pond	Concord	P1 (LMB & SMB), P3 (LMB & SMB)	Mercury
Walden Pond	Lynn, Lynnfield, Saugus	P1 (LMB), P3 (LMB)	Mercury
Wampanoag, Lake	Ashburnam, Gardner	P1 (all species), P5	Mercury
Warner's Pond	Concord	P1 (LMB), P3 (LMB)	Mercury
Wenham Lake	Beverly, Wenham	P1 (all species), P2 (AE, LMB), P4	Mercury, DDT
Wequaquet Lake	Barnstable	P1 (LMB, SMB), P3 (LMB, SMB)	Mercury
West Monponsett Pond	Halifax, Hanson	P1 (LMB), P3 (LMB)	Mercury
Whitehall Reservoir	Hopkinton	P1 (all species), P2 (YB), P4	Mercury
Whitings Pond	North Attleborough, Plainville	P1 (B, LMB), P3 (B, LMB)	Mercury
Whitmans Pond	Weymouth	P1 (AE), P2 (AE)	DDT
Whitney Pond	Winchendon	P1 (all species), P2 (CP), P4	Mercury
Windsor Lake	Windsor	P1 (LMB), P2 (LMB)	Mercury
Willet Pond	Walpole, Norwood, Westwood	P1 (LMB), P3 (LMB)	Mercury
Winthrop, Lake	Holliston	P6	Dioxin
Wrights Reservoir	Gardner, Westminster	P1 (all species), P5	Mercury

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Advice Codes

P1 (all species)	Children younger than 12 years or age, pregnant women, women of childbearing age who may become pregnant, and nursing mothers should not eat any fish from this water body.
P1 (species)	Children younger than 12 years or age, pregnant women, women of childbearing age who may become pregnant, and nursing mothers should not eat any of the affected fish species (in parenthesis) from this water body.
P2 (species)	The general public should not consume any of the affected fish species (in parenthesis) from this water body.
P3 (species)	The general public should limit consumption of affected fish species (in parenthesis) to two meals per month.
P4	The general public should limit consumption of non-affected fish from this water body to two meals per month.
P5	The general public should limit consumption of all fish from this water body to two meals per month.
P6	No one should consume any fish from this water body.

Fish Codes

AE	American Eel	CCS	Creek C hubsucker	SMB	Smallmouth Bass
B	Bluegill	CP	Chain Pickerel	WC	White Catfish
BB	Brown Bullhead	FF	Fallfish	WP	White Perch
BC	Black Crappie	GRS	Green Sunfish	WS	White Sucker
BT	Brown Trout	LMB	Largemouth Bass	YB	Yellow Bullhead
C	Carp	LNS	Longnose Sucker	YP	Yellow Perch
CB	Calico Bass	P	Pumpkinseed		
CC	Channel Catfish	RT	Rainbow Trout		

Hazard Codes

PCB=polychlorinated biphenyls
PAHs=polycyclic aromatic hydrocarbons

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NESCAUM
www.nescaum.org
Northeast States for Coordinated Air Use Management
89 South Street, Suite 602 Boston, MA 02111
Phone 617-259-2000 Fax 617-742-9162
Paul J. Miller, Executive Director

It Remains "Appropriate and Necessary" to Regulate Toxic Air Emissions from Coal- and Oil-fired Electric Generating Units

By Barbara Morin and Paul J. Miller
April 17, 2019

I. Introduction

a. Overview

The Northeast States for Coordinated Air Use Management (NESCAUM)[1] has developed this report in response to the February 7, 2019 U.S. Environmental Protection Agency (EPA) Proposed Rule *National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units—Reconsideration of Supplemental Finding and Residual Risk and Technology Review*[2] (referred to here as the "Reconsideration Proposal"). In this action, EPA has proposed to withdraw its long-standing and well-documented "appropriate and necessary" finding first made in 2000[3] and subsequently reaffirmed in 2012[4] and 2016.[5] The finding underpins pollution control requirements for mercury and other hazardous air pollutants (HAPs, also referred to as "air toxics") emitted by coal- and oil-fired electric generating units (EGUs). EPA established these requirements in the 2012 Utility Mercury and Air Toxics Standards (MATS)[6] and the affected EGUs have now complied with the emission limits. MATS continued existence, however, could be put at legal risk should EPA withdraw the rule's "appropriate and necessary" basis.

Prior to MATS, the states in the NESCAUM region, as well as a number of other states, developed their own state programs to control mercury, an important air toxic emitted by coal-fired EGUs. The state rulemakings often took a "multi-pollutant" approach that also included requirements to reduce emissions of acid- and ozone-forming precursor pollutants (e.g., nitrogen oxides, sulfur dioxide). During the development of their rules, the states used a number of approaches in assessing the costs, benefits, and feasibility of controlling multiple pollutants

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[1] NESCAUM is the regional association of the state air pollution control agencies in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont (www.nescaum.org).
[2] 84 Fed. Reg. 2670-2704 (February 7, 2019).
[3] 65 Fed. Reg. 79,825-79,831 (December 20, 2000).
[4] 77 Fed. Reg. 9304-9513 (February 16, 2012).
[5] 81 Fed. Reg. 24,420-24,452 (April 25, 2016).
[6] 77 Fed. Reg. 9304-9513 (February 16, 2012).

within a single program. Because the state rules pre-dated the original federal promulgation of MATS, they served as early examples of the practicality of the later MATS requirements.

Mercury has received special attention because of its elevated presence in commercially and recreationally important fish consumed by the public, as well as its adverse environmental impacts on loons and other wildlife. Due to elevated fish mercury levels, all the NESCAUM states have issued fish consumption advisories for fish caught in most or all the waters within each state.[7] To address this problem, New York and the New England states successfully petitioned EPA in 2007 to establish a Northeast Regional Mercury Total Maximum Daily Load (TMDL) under section 303(d) of the Clean Water Act.[8] The Northeast Regional Mercury TMDL established a mercury budget at a reduced level that the states project will allow for safe fish consumption and the lifting of state fish consumption advisories.

In setting their regional TMDL, the Northeast states considered multiple cross-media mercury sources. These encompassed out-of-region and in-region combustion sources emitting mercury to the air that subsequently deposited to the surface, municipal wastewater treatment plants directly discharging to water, non-municipal wastewater discharges, and stormwater. Based on 1998 emissions, modeled atmospheric deposition contributed 97.9 percent of the total mercury load to the region's waters, with the majority share coming from out-of-region sources. In order to achieve the target fish tissue mercury concentrations, the states determined it will require an at least 98 percent reduction in atmospheric mercury deposition arising from anthropogenic sources relative to 1998 levels.[9]

To address mercury released within their own borders, the Northeast states have been implementing multiple rules limiting mercury emissions from in-state emission sources. These measures have included limits on coal-fired power plants, medical waste incinerators, municipal waste combustors, and sewage sludge incinerators.[10] Initial measures reduced the modeled in-

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[7] *See* U.S. EPA, *State, Territory and Tribe Fish Advisory Contacts*, https://fishadvisoryonline.epa.gov/Contacts.aspx (accessed April 5, 2019).
[8] US EPA Region 1 letter to CT DEP, *Notification of Approval of Northeast Mercury TMDL* (December 20, 2007). New Jersey followed with its own successful mercury TMDL petition in 2009 [EPA Region 2 Decision Letter, *Review of Total Maximum Daily Load (TMDL) for Mercury Impairments Caused Mainly by Air Deposition in 122 HUC 14s Statewide, New Jersey (NJ)* (September 29, 2009)].
[9] New England Interstate Water Pollution Control Commission, *et al.*, *Northeast Regional Mercury Total Maximum Daily Load* (October 24, 2007). Available at http://click.neiwpcc.org/mercury/mercury-docs/FINAL%20Northeast%20Regional%20Mercury%20TMDL.pdf (accessed April 5, 2019).
[10] NESCAUM, *Tracking Progress in Reducing Mercury Air Emissions* (September 2007). Available at http://www.nescaum.org/documents/northeast-states-succeed-in-reducing-mercury-in-the-environment/final-

region mercury deposition contribution attributable to Northeast state sources from 43 percent in 1998 to 19 percent in 2002. Conversely, the modeled relative in-region contribution from out-of-region sources (upwind states and international) rose from 57 percent in 1998 to 81 percent in 2002.[11]

While the Northeast states have made significant progress in reducing in-region mercury releases, these reductions will not be sufficient to ensure that fish are safe to eat unless comparable out-of-region national and international measures occur. According to the Northeast Regional Mercury TMDL analysis:

> The Northeast region's ability to achieve the calculated TMDL allocations is dependent on the adoption and effective implementation of national and international programs to achieve necessary reductions in mercury emissions. Given the magnitude of the reductions required to implement the TMDL, the Northeast cannot reduce in-region sources further to compensate for insufficient reductions from out-of-region sources. . . . Specifically, it is Northeast States' position that the data and analyses in this TMDL demonstrate that: . . . (B.) EPA must implement significant reductions from upwind out-of-region sources, primarily coal-fired power plants; and (C.) MACT provisions of section 112(d) of the CAA should be adopted as the mechanism for implementing this TMDL.[12]

After having moved forward, however, EPA now seeks to reverse course by adopting a new and highly restrictive view of the value of the health and environmental benefits achieved by MATS. The new analysis dismisses the majority of the benefits associated with reducing EGU air toxics, and as a result, the Agency now asserts that the remaining benefits no longer justify the "appropriate and necessary" finding that forms the legal basis for MATS.

Although the Agency has not proposed withdrawing the MATS emission standards, if EPA were to finalize its withdrawal of the finding, it could pave the way for administrative appeal or expose MATS to future legal challenge that could result in a court striking down the standards, and put the Northeast states' public health and environment at increased risk. Vacating MATS would create economic incentives for coal- and oil-fired EGUs not to operate, or operate at diminished effectiveness, their installed pollution controls where not required for other purposes.

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nescaum-mercury-success-story.pdf/ (accessed April 5, 2019).
[11] New England Interstate Water Pollution Control Commission, *et al.*, *Northeast Regional Mercury Total Maximum Daily Load* (October 24, 2007), at p. 7.
[12] *Ibid.* at p. 44.

As noted in this document, there is historical precedent for EGUs dialing back or turning off installed pollution controls when not required to operate them. Because the Northeast states are downwind from states with large coal- and oil-fired EGUs that lack their own state standards that could backup the loss of MATS, increased air toxic emissions from those states will result in increased deposition within the Northeast region.

This document provides a broader overview of the extent of the numerous impacts that HAPs emitted by coal- and oil-fired EGUs have on public health and the environment. Rather than fully accounting for these in its Reconsideration Proposal, EPA selectively ignores or overly discounts multiple other exposure pathways (e.g., most fish consumption pathways for mercury exposure) and multiple other benefits from reducing the public's exposure through those pathways (e.g., decreased risk of fatal heart attacks and diabetes). EPA also discounts to zero the impacts of air toxics to the environment, such as known impacts of mercury on wildlife.

EPA also applies a new approach to cost-benefit analysis that is ill-suited for assessing the full benefits of reducing HAPs from coal- and oil-fired EGUs. EPA uses a cost-benefit approach that is overly narrow and heavily discounts or ignores hard to monetize benefits. This approach is incomplete and potentially misleading when applied to air toxics where many of the adverse impacts, hence benefits, occur over long time periods or are widely disbursed and difficult to directly link to a unique causal factor at a specific point in time. States that previously adopted their own multipollutant pollution control programs recognized that the full benefits of their rules were not always amenable to monetization,[13] and therefore considered the multiple health and environmental benefits using a broader set of considerations.

Furthermore, EPA, in a reversal of long-standing regulatory practice and at odds with the federal government's own guidelines, dismisses the co-benefits from reductions in fine particulate matter that it asserts are not the "target pollutants" under MATS. Most non-mercury metal air toxics, however, are physically bound within primary particulate matter emitted by coal- and oil-fired EGUs and are reduced by using particulate matter pollution controls. Therefore, reductions in particulate matter are a natural and unavoidable consequence of the MATS requirements to reduce non-mercury metal air toxics. EPA's revised approach ignores this direct relationship and

[13] *See, e.g.*, Delaware Department of Natural Resources & Environmental Control, Division of Air & Waste Management, Air Quality Management Section, *Technical Support Document for Proposed Regulation No. 1146, Electric Generating Unit (EGU) Multi-Pollutant Regulation*, September 2006 (p. 62). Available at: http://www.dnrec.delaware.gov/dwhs/Info/Regs/Documents/8969c5c8305d44318a38de77339cdf66multi_p_TechSptDoc1.pdf.

assigns it no benefit.

Based on a fuller accounting of the health and environmental benefits as well as historical control costs of the MATS requirements, and consistent with long standing regulatory analysis prior to the narrow approach EPA adopts in the Reconsideration Proposal, we conclude that EPA lacks a reasonable basis for its proposed action and that it remains both appropriate and necessary to regulate toxic air emissions from coal- and oil-fired EGUs.

b. NESCAUM background

NESCAUM was established in 1967 as a forum among its northeastern state members to exchange technical information, promote cooperation in regard to air pollution control issues of regional concern, and assist the states in implementing national environmental programs required under the Clean Air Act and other federal legislation. To accomplish these objectives, NESCAUM facilitates technical committees and workgroups, sponsors frequent air quality trainings, participates in national discussions, and organizes a variety of research initiatives. Many of NESCAUM's activities culminate in technical analyses, published reports, and workshops designed to provide support to our member states or disseminate state-of-the-art information concerning air pollution control issues.

With respect to air toxics, NESCAUM has been deeply involved over a number of years in the evaluation of their impacts on public health and the environment within the Northeast. These activities include:

- Analyzing the trace metal and sulfur content in wood fuels and heating oil sold in the Northeast;
- Reviewing control technologies to reduce conventional and hazardous air pollutants from coal-fired EGUs;
- Characterizing organic HAPs and other air pollutants from wood burning appliances;
- Evaluating relative cancer risks from conventional and reformulated gasolines;
- Quantifying the comparative contributions of different mercury pollution sources and source regions to mercury deposited from the air to land and water in the Northeast;
- Conducting state-level monitoring and modeling analyses of air toxics; and
- Improving source-specific estimates in mercury air emission inventories within the NESCAUM states.

A more complete listing of these and other NESCAUM activities with links to individual documents is available at www.nescaum.org.

c. Mercury and other hazardous air pollutants in the Northeast

The EPA has presented a summary of the cancer and non-cancer impacts for mercury, the non-mercury toxic metals, acid gases, and organic HAPs, including dioxins/furans that the MATs rule addresses.[14] Mercury has received special attention as a health and environmental problem among the NESCAUM states. Mercury deposition from upwind sources has significantly affected aquatic and terrestrial environments in the Northeast, resulting in states having to issue fish consumption advisories to protect human health.

Over 15,000 fish samples collected in the Northeast confirm widespread mercury contamination of aquatic ecosystems, threatening human health and wildlife without broad regional efforts to reduce significant local and upwind sources of mercury emissions. Mercury contamination also threatens the tourist and recreational fishing industries, which contribute $3 billion a year to the Northeast's regional economy.

In a 1997 study, the EPA modeled the transport and deposition of mercury emissions associated with selected categories of major combustion and manufacturing sources, including coal- and oil-fired EGU boilers. The study showed that the Northeast had one of the highest annual mercury deposition rates in the country and that, in areas with flat terrain, at least 75 percent of the mercury emitted by the modeled facilities was transported more than 50 km downwind from the facility. Monitoring data corroborated the modeling results.[15]

In 2007, NESCAUM conducted a modeling study to apportion contributions, by geographical area and by source category, to mercury deposition in the NESCAUM region. The analysis used an emissions inventory[16] developed by NESCAUM for 2002, after controls were implemented in the region for three mercury emission source categories: municipal waste combustors; medical waste incinerators; and sewage sludge incinerators. The modeling study calculated that in 2002, upwind sources in states outside of the NESCAUM region were responsible for nearly 60% of the domestic U.S. contribution to deposition in the NESCAUM states; upwind EGUs alone were

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[14] US EPA, *Regulatory Impact Analysis for the Final Mercury and Air Toxics Standards*, EPA-452/R-11-011 (December 2011).
[15] US EPA, *Mercury Study Report to Congress, Volume III: Fate and Transport of Mercury in the Environment*, EPA-452/R-97-005 (1997).
[16] NESCAUM, *Inventory of Anthropogenic Mercury Emissions in the Northeast*, Boston, MA (2005). Available at http://www.nescaum.org/documents/inventory-of-anthropogenic-mercury-emissions-in-the-northeast/.

responsible for 36% of those impacts.[17] As an outgrowth of this work, all the NESCAUM states, collectively or individually, petitioned EPA under the Clean Water Act to establish total maximum daily loads (TMDLs) for mercury entering the waters of the Northeast, which EPA approved.[18]

Working with the New England Interstate Water Pollution Control Commission (NEIWPCC), NESCAUM in 2008 used an EPA-sponsored modeling analysis[19] to further refine its previous results showing that much of the mercury entering the Northeast's aquatic ecosystems is deposited from the air, and a significant portion of this mercury comes from emission sources outside the region. That analysis concluded that nearly half of the mercury associated with U.S. sources that is deposited across New York and the New England states comes from within these states and another 40 percent is attributable to sources in states immediately upwind, including Pennsylvania, New Jersey, Ohio, West Virginia, and Maryland.[20] As part of a Clean Water Act sec. 319(g) conference that focused on mercury TMDL water quality impairment issues in New York and the six New England states, EPA reviewed NESCAUM's analysis and found its results virtually identical with EPA's own results.[21]

While mercury receives a large share of the attention, other non-mercury air toxic emissions from coal- and oil-fired EGUs affect the Northeast. For example, researchers have implicated nickel emissions from oil combustion with an increased risk in daily mortality.[22] In the Northeast, EGUs burning No. 6 residual oil are a large source of these emissions.

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[17] NESCAUM, *Modeling Mercury in the Northeast United States*, Boston, MA (2007). Available at http://www.nescaum.org/documents/mercury-modeling-report_2007-1005b_final.pdf/.

[18] US EPA Region 1 letter to CT DEP, *Notification of Approval of Northeast Mercury TMDL* (December 20, 2007) (this is a regional mercury TMDL covering the states of CT, ME, MA, NH, NY, RI and VT); EPA Region 2 letter to NJ DEP, *Review of Total Maximum Daily Load (TMDL) for Mercury Impairments Caused Mainly by Air Deposition in 122 HUC 14s Statewide, New Jersey (NJ)* (September 25, 2009).

[19] US EPA. "Model-based Analysis and Tracking of Airborne Mercury Emissions to Assist in Watershed Planning." Final Report, U.S. EPA Office of Wetlands, Oceans, and Watersheds, Washington, DC (August 2008), http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/upload/final300report_10072008.pdf (accessed June 11, 2011).

[20] NESCAUM, *Sources of Mercury Deposition in the Northeast United States*, Boston, MA (2008). Available at http://www.nescaum.org/documents/nescaum-sources-of-hg-depo-in-northeast_2008-final.pdf/. The modeling results are consistent with NESCAUM's earlier 2007 assessment, with the differences between in-region and out-of-region source contributions to Northeast deposition attributable to differences in each model's mercury emissions inventories, emitted mercury species profiles by source type, meteorological years, and boundary conditions (*see* p. 12).

[21] US EPA. "Determination of Mercury Deposition Contributions from States Outside the Northeast." Presentation by Dwight Atkinson, U.S. EPA, at Clean Water Act Section 319(g) Mercury Conference, Philadelphia, PA, June 22-23, 2010.

[22] Lippmann, M., K. Ito, J.S. Hwang, P. Maciejczyk, and L.C. Chen. Cardiovascular Effects of Nickel in Ambient

d. NESCAUM state efforts to reduce mercury released into the environment

In light of the dangers posed by mercury contamination, the Northeast states have been aggressively regulating in-region mercury releases to the air for a number of years. These efforts have been aimed at reducing mercury in products entering into waste streams, in addition to direct releases into air and water. A summary of efforts in 2007 noted:

> Since 2000, the Northeast states have enacted major legislation to address mercury use in products and ultimately in solid and hazardous waste. […] Mercury collection and recycling efforts by the Northeast States led to an estimated 7.5 tons of mercury recovered from homes, schools, hospitals, and other locations throughout the region. Some of the actions that have contributed to these reductions include the recycling of 41,764 mercury-containing thermostats, the collection of 120,973 mercury automobile switches and 213,322 mercury thermometers, and the removal of 4,696 lb of mercury from 456 schools.[23]

Additional efforts among the Northeast states include adopting laws or regulations requiring the installation of dental amalgam separators in dental offices to reduce the amount of mercury going to wastewater treatment facilities. Strict emission limits on municipal waste combustors reduced their mercury air emissions in the Northeast states by 85% from the late 1990s, from more than 14,000 lb to approximately 2,000 lb of emitted mercury. Additional deep reductions have occurred from medical waste incinerators within the region, where state limits resulted in mercury decreases of greater than 95% from these sources, falling from almost 1,600 lb in 1998 to 58 lb in 2002.[24]

Prior to the federal MATS rule in 2011, the NESCAUM states had already begun imposing by rule or legislation stringent mercury limits on coal-fired EGUs, and these were largely in place by the mid-2000s. Emissions requirements for coal-fired EGUs adopted in the Northeast include the following:

- Connecticut enacted legislation in June 2003 requiring coal-fired units in the state to meet emissions requirements by July 1, 2008.[25]
- Massachusetts promulgated regulations in May 2004 to limit mercury emissions from

Air. *Environ. Health Perspect.* 114(11): 1662-1669 (2006).

[23] King, S., P. Miller, T. Goldberg, J. Graham, S. Hochbrunn, A. Wienert, and M. Wilcox. Reducing Mercury in the Northeast United States. *EM*, Air & Waste Management Association (Pittsburgh, PA), pp. 9-13 (May 2008).

[24] *Ibid.*

[25] Connecticut General Statute section 22a-199 (2003).

four large coal-fired EGUs in the state relative to 2000-2001 levels.[26] The deadline for compliance with Phase 1 (minimum 85% mercury capture) of those requirements was January 1, 2008. Compliance with more stringent Phase II requirements (minimum of 95 percent mercury capture) was required by October 1, 2012.

- New Hampshire adopted state legislation calling for a state-wide 80 percent reduction in coal-fired EGU mercury emissions no later than July 1, 2013.[27]
- New Jersey adopted rules in August 2005 limiting mercury emissions from coal-fired boilers by December 15, 2007.[28]
- New York State adopted rules in 2007 capping mercury emissions from coal-fired EGUs in the years 2010-2014 and limiting those emissions by 2015.[29]

Many of these state emission limits are well below that required by the federal MATS rule.

e. State rules did not impose significant burdens on costs of reliability

Prior to EPA's final promulgation of MATS, a number of states had already adopted stringent limitations on mercury emissions from new and existing fossil fuel EGUs, often as part of multi-pollutant programs that included control cost considerations for sulfur dioxide (SO_2) and nitrogen oxides (NO_X). Rules covering EGUs in Delaware,[30] Maryland,[31] Massachusetts,[32] New

[26] 310 CMR 7 (2004).
[27] RSA 125-O:11-18 (2006).
[28] N.J.A.C. 7:27-27.1 *et seq.* (2004).
[29] 6 NYCRR Part 246 (2007).
[30] Delaware Department of Natural Resources & Environmental Control, Division of Air & Waste Management, Air Quality Management Section, *Technical Support Document for Proposed Regulation No. 1146, Electric Generating Unit (EGU) Multi-Pollutant Regulation*, September 2006 (pp. 47-56). Available at: http://www.dnrec.delaware.gov/dwhs/Info/Regs/Documents/8969c5c8305d44318a38de77339cdf66multi_p_TechSptDoc1.pdf.
[31] Maryland Department of the Environment, *Technical Support Document for Proposed COMAR 26.11.27, Emission Limitations for Power Plants*, December 26, 2006 (pp. 36-41). Provided by the Maryland Department of the Environment and included as an attachment to these comments.
[32] Massachusetts Department of Environmental Protection, Bureau of Waste Prevention, Division of Planning and Evaluation, *Evaluation of the Technological and Economic Feasibility of Controlling and Eliminating Mercury Emissions from the Combustion of Solid Fossil Fuel*, December 2002. Available at: www.mass.gov/eea/docs/dep/toxics/stypes/mercfeas.pdf.

Jersey,[33] New York,[34] and Wisconsin[35] are illustrative of the cost considerations taken by these states.

In their rulemakings, the states recognized a broader range of public health and environmental benefits and put these considerations within an overall cost context affecting the electric generation industry as well as consumers. For example, Delaware and New York estimated the impact of their rules on retail electricity prices. While they projected an increase in cost of electricity generation for the affected EGUs, they concluded that it was not of sufficient magnitude to expect increased rates for consumers.[36,37]

With state rules now having been in place for over a decade, the historical experience in the states that adopted mercury standards show that the control costs did not impose an unreasonable burden on the covered EGUs, did not cause a drastic rise in electricity rates, and did not undermine electric grid reliability. As discussed below, a retrospective analysis of the MATS implementation, which has comparable requirements to those in the state rules, showed that actual costs were lower than projected costs and did not adversely affect the reliability of the grid.[38]

II. Control Costs

Actual control costs for EGUs to comply with MATS have been less than originally estimated by

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[33] New Jersey Register, *Air Pollution Control: Control and Prohibition of Mercury Emissions*, Vol. 36, No. 1, 123(a), January 5, 2004 (available on-line via LexisNexis® at http://www.lexisnexis.com/njoal/).

[34] New York State Department of Environmental Conservation, 6 NYCRR Part 246, *Mercury Reduction Program for Coal-Fired Electric Utility Steam Generating Units*, 6 NYCRR Part 200.9, *Referenced Material Revised Regulatory Impact Statement*, 2006. Available upon request from the New York State Department of Environmental Conservation and included as an attachment to these comments.

[35] Wisconsin Department of Natural Resources, Bureau of Air Management, *Factsheet on Rule to Control Mercury Emissions from Coal-Fired Power Plants*, revised August 2008. Available at: http://dnr.wi.gov/files/PDF/pubs/am/AM392.pdf.

[36] Delaware Department of Natural Resources & Environmental Control, Division of Air & Waste Management, Air Quality Management Section, *Technical Support Document for Proposed Regulation No. 1146, Electric Generating Unit (EGU) Multi-Pollutant Regulation*, September 2006 (p. 50). Available at: http://www.dnrec.delaware.gov/dwhs/Info/Regs/Documents/8969c5c8305d44318a38de77339cdf66multi_p_TechSptDoc1.pdf.

[37] New York State Department of Environmental Conservation, 6 NYCRR Part 246, *Mercury Reduction Program for Coal-Fired Electric Utility Steam Generating Units*, 6 NYCRR Part 200.9, *Referenced Material Revised Regulatory Impact Statement*, 2006 (p. 24). Available upon request from the New York State Department of Environmental Conservation and included as an attachment to these comments.

[38] *White Stallion Energy Center, LLC v. EPA*, D.C. Circuit Case No. 12-1100, Motion of Industry Respondent Intervenors to Govern Future Proceedings, filed September 24, 2015 (*see* Declaration of James E. Staudt and accompanying exhibits).

EPA. A retrospective analysis of MATS compliance costs by industry representatives estimated those costs to be about $2 billion annually, which is less than one-quarter of EPA's prospective annual cost estimate of $9.6 billion.[39] A number of factors contributed to the substantially lower actual compliance costs. These factors include:[40]

1) Improved dry sorbent injection and activated carbon injection technologies at significantly lower costs;
2) Significantly lower natural gas prices than EPA estimated; and
3) Less generation capacity installing fabric filters, dry flue gas desulfurization (FGD) systems, and wet FGD upgrades than EPA estimated.

It is not unusual for the actual costs of complying with air pollution regulations to be substantially lower than pre-compliance estimates. NESCAUM's 2000 retrospective review of several air pollution programs found a repeated pattern of high EPA cost estimates and much higher industry cost projections (often by a factor of two or more) as rules were promulgated, with lower actual compliance costs once the programs were implemented. Examples of programs for which costs were prospectively overestimated include the California Low Emissions Vehicle program and requirements for SO_2 controls pursuant to Title IV of the Clean Air Act.[41]

III. Northeast states will be adversely impacted if MATS requirements are rescinded

a. Withdrawing the "appropriate and necessary" finding puts the MATS requirements at legal risk

In EPA's Reconsideration Proposal, the Agency does not propose to revoke the MATS standards (although it does invite comment on that option); EPA proposes only to withdraw the "appropriate and necessary" finding. Withdrawing the finding—which, under the Clean Air Act obligates EPA to regulate EGU HAPs—could render the MATS standards vulnerable to legal challenge. Should the MATS standards be vacated or rescinded by future legal or administrative action, it creates the threat that EGUs now in full compliance with MATS would stop operating their installed controls. This is not entirely speculation, as the following historical context shows.

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[39] *Ibid.* Staudt Declaration.
[40] *Ibid.* Staudt Declaration.
[41] NESCAUM, *Environmental Regulation and Technology Innovation: Controlling Mercury Emissions from Coal-Fired Boilers*, September 2000. Available at: http://www.nescaum.org/documents/rpt000906mercury_innovative-technology.pdf.

Ceasing operations of those controls would cause adverse impacts in downwind Northeast states.

b. Operation of installed controls

The initial MATS compliance deadline was April 16, 2015. According to the U.S. Energy Information Administration (EIA), coal-fired plants with a total capacity of 87 GW installed pollution-control equipment and nearly 20 GW of coal capacity was retired by that date. The EPA granted one-year extensions to coal plants with a total capacity of 142 GW, which allowed those facilities to operate until April 2016 while finalizing compliance strategies.[42]

An additional one-year extension, to April 2017, was granted to five plants with a combined capacity of 2.3 GW to ensure electric reliability. Two of those five plants were retired, one converted to natural gas, and one installed MATS-compliant controls by that date. The remaining plant, Oklahoma's Grand River Energy Center, was given another emergency extension to July 2017 for reliability issues,[43] and complied with MATS requirements in 2017.[44]

There typically is a financial cost associated with operation of the controls used to remove regulated pollutants from EGU emissions.[45] As a result, there is an economic incentive for EGUs to discontinue operating pollution controls absent an enforceable obligation to do so under a permit, regulation, or court order.[46] For example, an analysis by the Ozone Transport Commission showed that in 2012, numerous coal-fired EGUs equipped with post-combustion NO_X emission controls, in particular selective catalytic reduction controls, stopped or limited operation of those controls and instead chose to achieve compliance with the federal Clean Air Interstate Rule by purchasing NO_X emissions allowances, presumably because it was less expensive to do so.[47] A specific example is the coal-fired Montour Power Plant in Pennsylvania,

[42] US EIA, Coal Plants Installed Mercury Controls to Meet Compliance Deadlines, *Today in Energy*, (September 18, 2017), https://www.eia.gov/todayinenergy/detail.php?id=32952#.
[43] *Ibid.*
[44] US EIA, 2017 Form EIA-860 Data – Schedule 6B, Emission Standards and Control Strategies, (September 13, 2018) https://www.eia.gov/electricity/data/eia860/.
[45] Examples of these costs are for the purchase of control reagents, parasitic energy load to run the controls, and additional operation and maintenance of the control equipment.
[46] McNevin, T.F., Recent increases in nitrogen oxide (NO_X) emissions from coal-fired electric generating units equipped with selective catalytic reduction, 66 *JAWMA* 66-75 (2016), DOI: 10.1080/10962247.2015.1112317.
[47] *See* Statement from the Ozone Transport Commission Requesting the Use and Operation of Existing Control Devices Installed at Electric Generating Units (June 13, 2013), http://www.otcair.org/upload/Documents/Formal%20Actions/Statement_EGUs.pdf.

where a company spokesperson stated that in 2015, it was much cheaper to buy allowances than run its already installed NO_X controls.[48]

Thus, there is precedent to expect that the coal-fired EGUs not located within the 11 states[49] requiring controls under state law will not operate or will limit operation of the controls that they installed to comply with MATS requirements if that rule is no longer in effect. This is particularly likely for controls specific to mercury reduction, such as activated carbon injection and halogen (e.g., bromine) addition, that cost money to operate and that can be readily turned off without affecting compliance with other non-mercury pollution control obligations.

Given that the majority of the nation's coal-fired EGU capacity is located in states without state-based mercury controls—such as Indiana, Pennsylvania, Ohio, West Virginia, and Texas—uncontrolled mercury emissions in the event of full or partial vacatur or repeal of MATS could be substantial. Uncontrolled mercury emissions from Pennsylvania's coal-fired EGUs are of particular concern to the NESCAUM states because Pennsylvania has numerous coal-fired EGUs and contributes significantly to mercury deposition in the NESCAUM states, due to its proximity to the region and prevailing weather patterns.[50]

c. Impacts of mercury deposition on natural resources

As documented in recent studies, reductions in mercury emissions associated with implementation of state and federal rules have resulted in decreased mercury levels in waterbodies and in freshwater and saltwater fish. Examples of studies documenting those reductions include:

- Core sediment samples taken from the Great Lakes and nearby lakes showed a 20% mean decline in mercury accumulation attributable to domestic emissions reductions.[51]
- Mercury concentrations in largemouth bass and yellow perch in lakes in a mercury

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[48] O'Neill, J.M., *N.J. Air Quality Takes a Hit*, The Record (Bergen County, NJ), May 17, 2015 (quoting a company spokesperson, "[t]oday, the cost of using installed controls far exceeds the cost of obtaining allowances in the trading market.").
[49] *See* 5 COLO. CODE REGS. § 1001-8:B.VIII.c (first phase compliance by Jan. 1. 2012); CONN. GEN. STAT. § 22a-199(b)(1) (compliance by Jul. 1, 2008); DEL. ADMIN. CODE, tit. 7, § 1146-6.1 (first phase compliance by Jan. 1, 2009); ILL. ADMIN. CODE tit. 35, § 225.230(a) (compliance by Jul. 1, 2009); MD. CODE REGS. tit. 26, § 11.27.03.D (first phase compliance by Jan. 1, 2010); 310.
[50] NESCAUM 2008 Report, *supra* note 10, at 18 (showing that Pennsylvania contributed approximately 22 percent of all U.S. domestic mercury deposition in New York and the six New England states, even prior to when the NESCAUM states began to reduce their own power plant mercury emissions).
[51] Drevnick, P.E., *et al.*, Spatial and Temporal Patterns of Mercury Accumulation in Lacustrine Sediments across the Laurentian Great Lakes Region, 161 *Environ. Pollut.* 252-260 (2012), DOI: 10.1016/j.envpol.2011.05.025.

hotspot area of Massachusetts showed declines of 44% and 43%, respectively, between 1999 and 2011, a period in which major reductions in mercury air emissions from combustion sources occurred in the region.[52]

- A recent study convincingly linked mercury air emissions and mercury levels in saltwater fish tissue. The researchers reported that the concentration of mercury in bluefish collected off the North Carolina coast in 2011 was 43% lower than the concentration measured in 1972 and noted that this reduction, approximately 10% per decade, "is similar to estimated reductions of mercury observed in atmospheric deposition, riverine input, seawater, freshwater lakes, and freshwater fish across northern North America." The authors also cited eight additional studies conducted between 1973 and 2007 that confirm the decrease in mercury levels in bluefish captured in the Mid-Atlantic Bight (defined as the continental shelf waters from Cape Cod, Massachusetts, to Cape Hatteras, North Carolina) with decreasing U.S. mercury air emissions.[53]

Decreases in mercury contamination of fish are associated with human health benefits, as discussed in the following subsection. In addition, a reduction in mercury contamination will decrease the detrimental impacts on fish and fish-eating wildlife, including:

- Impacts on insectivorous terrestrial species such as songbirds, bats, spiders, and amphibians;
- Reproductive effects, including deficits in sperm and egg formation, histopathological changes in testes and ovaries, and disruption of reproductive hormone synthesis in several fish species, including trout, bass (large and smallmouth), northern pike, carp, walleye and salmon;
- Significant adverse effects in breeding loons, including behavioral (reduced nest-sitting), physiological (flight feather asymmetry), and reproductive (chicks fledged/territorial pair) effects and reduced survival; and

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[52] Hutcheson, M.S., C.M. Smith, J. Rose, C. Batdorf, O. Pancorbo, C.R. West, J. Strube, and C. Francis. Temporal and Spatial Trends in Freshwater Fish Tissue Mercury Concentrations Associated with Mercury Emissions Reductions, 48 *Environ. Sci. Technol.* 2193-2202 (2014), DOI: 10.1021/es404302m.
[53] Cross, F.A., D.W. Evans, and R.T. Barber. Decadal Declines of Mercury in Adult Bluefish (1972–2011) from the Mid-Atlantic Coast of the U.S.A., 49 *Environ. Sci. Technol.* 9064–9072 (2015), DOI: 10.1021/acs.est.5b01953.

- Effects on the white ibis and other piscivorous bird species, including decreased foraging efficiency, decreased reproductive success and altered pair behavior, resulting in a reduction in fledglings.[54]

Mercury contamination of fishing areas, largely due to atmospheric mercury deposition, has led many states, including the NESCAUM member states, to issue widespread fish consumption advisories. Advisories warn residents, particularly women of child bearing age, to avoid or severely curtail fish consumption. Wildlife are not able to choose to avoid these exposures. Without MATS to limit these mercury emissions, the Northeast states will have little chance to address these persistent harms to the region's natural resources caused by EGUs located upwind and outside the region.

d. Impacts of mercury deposition on human health

As discussed above, emitted mercury, when deposited in or carried into waterbodies, is readily converted to methylmercury (MeHg), a particularly toxic and persistent form of mercury. MeHg bioconcentrates in the food chain, and, as a result, mercury levels in fish tissue can be as much as 10 to 100 million times greater than concentrations in water.[55] Therefore, consumption of fish, including freshwater fish and saltwater fish and shellfish, are the major route of human exposure to mercury.

Human health effects linked to mercury exposure include the following:

- Children exposed to MeHg during a mother's pregnancy can experience persistent and lifelong IQ and motor function deficits. There is no known threshold below which these effects do not occur.[56]
- In adults, high levels of MeHg exposure have been associated with adverse cardiovascular effects, including increased risk of fatal heart attacks.[57]
- Other adverse health effects of MeHg exposure that have been identified in the scientific

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[54] US EPA, *Regulatory Impact Analysis for the Final Mercury and Air Toxics Standards*, EPA-452/R-11-011 (December 2011), Chapter 4.

[55] Driscoll, C.T., Y.-J. Han, C. Chen, D. Evers, K.F. Lambert, T. Holsen, N. Kamman, and R. Munson. Mercury Contamination on Remote Forest and Aquatic Ecosystems in the Northeastern U.S.: Sources, Transformations, and Management Options, *BioScience* 57(1):17-28 (2007).

[56] Grandjean, P. and M. Bellanger. Calculation of the Disease Burden Associated with Environmental Chemical Exposures: Application of Toxicological Information in Health Economic Estimation, 16 *Environ. Health*, 123 (2017), DOI: 10.1186/s12940-017-0340-3.

[57] Genchi G., M.S. Sinicropi, A. Carocci, G. Lauria, and A. Catalano. Mercury Exposure and Heart Diseases, 14 *Int. J. Environ. Res. Public Health* 74 (2017), DOI:10.3390/ijerph14010074.

literature include endocrine disruption,[58] diabetes risk,[59] and compromised immune function.[60]

EPA's Regulatory Impact Analysis (RIA) in support of the MATS rule only monetized the effect of loss of IQ points for a certain subset of the exposed U.S. population. However, it is important that all of the health impacts listed above be carefully evaluated in any regulatory action that may increase mercury exposures. Consideration of cardiovascular effects is particularly critical. In 2011, a group of experts convened by EPA found "the body of evidence exploring the link between MeHg and acute myocardial infarction (MI) to be sufficiently strong to support its inclusion in future benefits analyses, based both on direct epidemiological evidence of an MeHg–MI link and on MeHg's association with intermediary impacts that contribute to MI risk."[61]

Note that fish with high MeHg levels also frequently have high levels of heart protective omega-3 fatty acids.[62] That correlation tends to mask the cardiovascular effects of MeHg in epidemiological studies and has made the development of quantitative risk factors for the MeHg-MI link more challenging. However, as discussed below, monetizing MI reductions associated with reduction in MeHg exposures would significantly increase the quantified benefits associated with the MATS rule.

As previously noted, a recent study convincingly linked decreased levels decreased mercury air emissions with decreased concentrations of MeHg in bluefish captured in the Mid-Atlantic Bight (the continental shelf waters from Cape Cod, Massachusetts, to Cape Hatteras, North Carolina).[63] The study's authors concluded that, assuming that bluefish are representative of other marine

[58] Tan, S.W., J.C. Meiller, and K.R. Mahaffey. The endocrine effects of mercury in humans and wildlife, *Crit. Rev. Toxicol.* 39 (3), 228−269 (2009).
[59] He, K., P. Xun, K. Liu, S. Morris, J. Reis, and E. Guallar. Mercury exposure in young adulthood and incidence of diabetes later in life: the CARDIA trace element study, 36 *Diabetes Care* 1584−1589 (2013).
[60] Nyland, J. F., M. Fillion, R. Barbosa, Jr., D.L. Shirley, C. Chine, M. Lemire, D. Mergler, and E.K. Silbergeld. Biomarkers of methylmercury exposure and immunotoxicity among fish consumers in the Amazonian Brazil, 119 *Environ. Health Perspect.* 1733− 1738 (2011).
[61] Roman, H.A., T.L. Walsh, B.A. Coull, E. Dewailly, E. Guallar, D. Hattis, K. Mariën, J. Schwartz, A.H. Stern, J.K. Virtanen, and G. Rice. Evaluation of the Cardiovascular Effects of Methylmercury Exposures: Current Evidence Supports Development of a Dose–Response Function for Regulatory Benefits Analysis, 119 *Environ. Health Perspect.* 607–614 (2011).
[62] Mahaffey, K.R., R.P. Clickner, and R.A. Jeffries. Methylmercury and Omega-3 Fatty Acids: Co-occurrence of Dietary Sources with Emphasis on Fish and Shellfish, 107 *Environ. Res.* 20–29 (2018).
[63] Cross, F.A., D.W. Evans, and R.T. Barber. Decadal Declines of Mercury in Adult Bluefish (1972–2011) from the Mid-Atlantic Coast of the U.S.A., 49 *Environ. Sci. Technol.* 9064–9072 (2015), DOI: 10.1021/acs.est.5b01953.

predators, reduced mercury releases will result in lower mercy public mercury exposures associated with eating marine fish. Those reductions in mercury intakes will likely have the largest benefit for women living in Atlantic coastal areas, who have, on average, higher mean mercury blood levels than other U.S. women of child-bearing age, as documented in the National Health and Nutrition Examination Survey.[64]

Consistent with the bluefish findings, another study found declining mercury concentrations in bluefin tuna in the Northwest Atlantic Ocean, and the declines paralleled decreases in North American mercury emissions being exported to the North Atlantic.[65] Because tuna species collectively provide more mercury (~40%) to the U.S. population than any other source,[66] it is clear that there will be significant health and economic benefits associated with saltwater fish consumption that come from reducing U.S. EGU mercury emissions.

The absence of MATS would put at risk public health in the Northeast states from the consumption of mercury-tainted fish, while diminishing the important health benefits of a diet that includes fish. In addition, the vitality of the Northeast's marine fisheries is put at risk, threatening the future prospects of an already stressed but economically important component of the Northeast states' economies.

e. Impacts on compliance with other Clean Air Act requirements

The EPA has incorporated MATS into its 2011 emissions modeling platform that projects emission baselines into the future.[67] States rely upon these projections in developing pollution control strategies to attain and maintain national ambient air quality standards (NAAQS). For example, Connecticut has included EPA's 2017 baseline projections for emissions of NO_X, which include MATS reductions, in its most recent ozone state implementation plan (SIP) submittal.[68] While MATS may not specifically require limitations on NO_X as an ozone precursor,

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[64] Cusack, L.K., E. Smit, M.L. Kile, and A.K. Harding. Regional and Temporal Trends in Blood Mercury Concentrations and Fish Consumption in Women of Child Bearing Age in the United States Using NHANES Data from 1999–2010, 16 *Environ. Health* 10-20 (2017), DOI: 10.1186/s12940-017-0218-4.

[65] Lee, C.-S., M.E. Lutcavage, E. Chandler, D.J. Madigan, R.M. Cerrato, and N.S. Fisher. Declining Mercury Concentrations in Bluefin Tuna Reflect Reduced Emissions to the North Atlantic Ocean, 50 *Environ. Sci. Technol.* 12825-12830 (2016), DOI: 10.1021/acs.est.6b04328.

[66] Sunderland, E.M. Mercury exposure from domestic and imported estuarine and marine fish in the U.S. seafood market, 115 *Environ. Health Perspect.* 235−242 (2007).

[67] US EPA, *Technical Support Document (TSD) Preparation of Emissions Inventories for the Version 6.2, 2011 Emissions Modeling Platform*, (August 2015). Available at https://www.epa.gov/sites/production/files/2015-10/documents/2011v6_2_2017_2025_emismod_tsd_aug2015.pdf.

[68] Connecticut Department of Energy and Environmental Protection, *8-Hour Ozone Attainment Demonstration for*

EPA has included the program in its projections because of its impact on reducing ozone precursor emissions in Connecticut and upwind states. Similarly, EPA has previously credited sulfur dioxide and particulate matter reductions from MATS in concluding that these would help eastern states meet the revised daily and annual fine particulate matter NAAQS with no additional controls needed.[69] Removal of MATS alters those projections and undermines the states' ability to achieve the relied-upon reductions associated with MATS to help attain and maintain compliance with the ozone and particulate matter national ambient air quality standards.

In addition to the national ambient air quality standards, EPA requires states to develop long-term strategies that address visibility-impairing haze in designated federally protected national parks and wilderness areas ("Class I areas"[70]), and these strategies must consider "Emission reductions due to ongoing air pollution control programs[.]"[71] As part of these considerations, EPA requires states with Class I areas to include MATS among the federal measures that they use to establish reasonable progress goals in their state haze plans.[72] In the NESCAUM region, four states have Class I areas – Maine, New Hampshire, New Jersey, and Vermont. Removal of MATS will hinder the ability of these and other states with Class I areas to achieve the reasonable progress goals in their haze plans.

IV. Co-benefits and non-monetized benefits of the MATS rule

In EPA's Reconsideration Proposal, it adopts for the first time a cost-benefit approach in which benefits that can be monetized are virtually the only factors considered in its "appropriate and necessary" finding. This overly constrains EPA's approach to one narrow slice of the full benefits reasonably attributable to MATS. EPA also for the first time dismisses the substantial

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the Connecticut Portion of the New York-Northern New Jersey-Long Island (NY-NJ-CT) Nonattainment Area, Technical Support Document, Enclosure A, Revision to Connecticut's State Implementation Plan (August 2017). Available at https://www.ct.gov/deep/lib/deep/air/ozone/ozoneplanningefforts/SouthwestConnecticutAttainmentSIPFINAL.pdf (*see* pp. 56-57).

[69] US EPA, *Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter*, EPA-452/R-12-005 (December 2012). Available at https://www3.epa.gov/ttnecas1/regdata/RIAs/finalria.pdf.

[70] "Class I areas" are national parks larger than 6,000 acres and national wilderness areas larger than 5,000 acres that were in existence when the Clean Air Act was amended in 1977. *See* National Park Service, *Class I Areas*, https://www.nps.gov/subjects/air/class1.htm (accessed March 22, 2019).

[71] 40 CFR 51.308(f)(2).

[72] 82 Fed. Reg. 3078-3129 (January 10, 2017), at 3092.

"co-benefits" from reductions in other air pollutants, most notably fine particulate matter, based on the assertion that these are not the intended target of MATS, therefore cannot be meaningfully considered. Neither of those drastic changes are consistent with good practice in economic analysis, and both contradict the federal government's own guidance in conducting a regulatory impact analysis.

a. Non-monetized benefits of HAP reductions

EPA's RIA for the MATS rule monetized only one exposure-health endpoint, loss of IQ points in children who were exposed prenatally to MeHg via maternal ingestion of self-caught freshwater fish. The RIA states that that endpoint was used because of "the availability of thoroughly-reviewed, high-quality epidemiological studies assessing IQ or related cognitive outcomes suitable for IQ estimation, and the availability of well-established methods and data for economic valuation of avoided IQ deficits."[73]

EPA did not attempt to monetize the benefits of reducing risks of any of the other health and environmental endpoints associated with exposure to MeHg that are listed above, including the increased risk of myocardial infarction in adults. It also did not monetize the benefits associated with a reduction in MeHg in saltwater fish and in commercially purchased fish. The RIA states that EPA did not attempt to monetize those pathways for two reasons: "(1) for self-caught saltwater fish, we are unable to estimate the reduction in fish tissue methylmercury that would be associated with reductions in mercury deposition from U.S. EGUs, and (2) for commercially purchased ocean fish, it is nearly impossible to determine the source of the methylmercury in those fish, and thus we could not attribute mercury levels to U.S. EGUs."[74] While NESCAUM recognizes that there are uncertainties in quantifying these exposures, it is essential that these pathways be included in any benefit analysis, because they are the main MeHg exposure pathways for most of the U.S. population.

b. Expanded quantitative analyses of the benefits of HAP reductions

Several recent analyses have estimated the benefits of the reductions in exposures to MeHg associated with lower EGU emissions. Those analyses, which have yielded benefit estimates that are considerably higher than those calculated in the RIA, include:

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[73] US EPA, *Regulatory Impact Analysis for the Final Mercury and Air Toxics Standards*, EPA-452/R-11-011 (December 2011), Chapter 4.
[74] *Ibid.*

- A calculation of societal costs associated with exposure to MeHg in the U.S., including costs borne by the health care system, by the individual and the household, and by employers and insurers. Those costs were valued at $4.8 billion per year.[75]
- Using a probabilistic model, researchers calculated that a 10% reduction in the U.S. population's exposure to MeHg would be associated with a savings of $860 million per year, based on reductions in fatal heart attacks and IQ gains.[76]
- A 2005 NESCAUM analysis calculated that the health benefits to the public associated with reduced EGU mercury emissions would be as high as $4.9 billion (2000$) per year. This analysis, which included health endpoints (e.g., cardiovascular effects and premature mortality) and exposure pathways (e.g., ocean-caught fish) that were not included in the RIA, assumed an EGU mercury emissions cap of 26 tons per year, based on an earlier EPA proposal. Because EPA's final MATS rule resulted in a four-fold greater decrease in EGU mercury emissions below NESCAUM's assumed 26 tons per year, the full health benefits of MATS would be even larger than suggested by NESCAUM's 2005 estimates.[77]

c. Consideration of benefits of HAP reductions that cannot be monetized

It is essential that EPA also meaningfully account for benefits associated with the MATS rule that cannot be monetized, and do so for both human health and ecological benefits. Frequently, there is more information available to monetize costs than benefits. While the regulated community has incentive and resources to estimate compliance costs (and, as noted earlier, typically overestimates costs), it has no such incentive to monetize public benefits. While government can help fill this information imbalance, it often lacks the resources to do so. Furthermore, benefits that accrue over long time periods or are widely disbursed and difficult to directly link to a unique causal factor at a specific point in time may be overly discounted or completely ignored.

The Office of Management and Budget's (OMB) guidance on best practices in conducting

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[75] Grandjean, P. and M. Bellanger. Calculation of the Disease Burden Associated with Environmental Chemical Exposures: Application of Toxicological Information in Health Economic Estimation, 16 *Environ. Health* 123 (2017), DOI: 10.1186/s12940-017-0340-3.
[76] Rice, G.E., J.K. Hammitt, and J.S. Evans. A Probabilistic Characterization of the Health Benefits of reducing Methyl Mercury Intake in the United States, 44 *Environ. Sci. Technol.* 5216-5224 (2010), DOI:10.1021/es903359u.
[77] NESCAUM, *Economic Valuation of Human Health Benefits of Controlling Mercury Emissions from U.S. Coal-Fired Power Plants,* February 2005. Available at: http://www.nescaum.org/documents/rpt050315mercuryhealth.pdf.

regulatory analyses clearly supports serious consideration of all benefits, including those that cannot be monetized. The OMB's 2003 Circular A-4 notes that "[w]hen important benefits and costs cannot be expressed in monetary units, benefit-cost analysis is less useful, and it can even be misleading, because the calculation of net benefits in such cases does not provide a full evaluation of all relevant benefits and costs.[78]

States that have adopted their own rules limiting mercury emissions from EGUs also identified numerous important benefits associated with their rules that they were not able to fully monetize. Delaware, for example, stated that, "while it is evident that economic benefits will accrue," it "was not able to obtain sources of information that quantify the economic impact of mercury emissions reductions on neurological effects, cardiovascular effects, genotoxic effects, immunotoxic effects, or ecological effects."[79] Consistent with the OMB's guidelines and states' experiences, NESCAUM believes that the presently quantifiable benefits do not capture the full value of HAPs reductions associated with the MATS rule, making EPA's proposed cost-benefit comparison incomplete and potentially misleading, thus necessitating the use of other approaches to better consider those benefits.

d. Consideration of co-benefits from reduction of criteria pollutant exposures

The EPA's 2016 Supplemental Finding included a formal cost-benefit analysis that found the monetized benefits associated with implementation of the MATS rule far outweighed the costs of compliance. In the Supplemental Finding, EPA stated that while in its preferred approach it was not relying on the rule's monetized co-benefits to reaffirm its "appropriate and necessary" finding, the results of its formal cost-benefit analysis provided further evidence in support of the basis for MATS.

In the current Reconsideration Proposal, EPA is proposing to reverse that finding because most of the monetized benefits calculated in the benefit-cost analysis are associated with what it views as ancillary reductions in non-HAP emissions. Specifically, most of the monetized benefits in the Supplemental Finding's formal cost-benefit analysis are associated with reductions in fine particulate matter ($PM_{2.5}$). Those reductions are a co-benefit of the installation of control

[78] Office of Management and Budget (OMB), *Circular A-4: Regulatory Analysis*, 2003, p. 10.
[79] Delaware Department of Natural Resources & Environmental Control, Division of Air & Waste Management, Air Quality Management Section, *Technical Support Document for Proposed Regulation No. 1146, Electric Generating Unit (EGU) Multi-Pollutant Regulation*, September 2006 (p. 62). Available at: http://www.dnrec.delaware.gov/dwhs/Info/Regs/Documents/8969c5c8305d44318a38de77339cdf66multi_p_TechSptDoc1.pdf.

technology that reduces emissions of $PM_{2.5}$, nitrogen oxides and sulfur dioxide, as well as HAPs. Note that in addition to direct (primary) $PM_{2.5}$ emissions from EGUs, nitrogen oxides and sulfur dioxides emitted by EGUs react in the atmosphere to form secondary $PM_{2.5}$.

The EPA's minimization of the importance of co-benefits (also called ancillary benefits) in the Reconsideration Proposal contradicts guidance on this subject in OMB's Circular A-4, which states the following:

> Your analysis should look beyond the direct benefits and direct costs of your rulemaking and consider any important ancillary benefits and countervailing risks. An ancillary benefit is a favorable impact of the rule that is typically unrelated or secondary to the statutory purpose of the rulemaking (e.g., reduced refinery emissions due to more stringent fuel economy standards for light trucks) while a countervailing risk is an adverse economic, health, safety, or environmental consequence that occurs due to a rule and is not already accounted for in the direct cost of the rule (e.g., adverse safety impacts from more stringent fuel-economy standards for light trucks).
>
> You should begin by considering and perhaps listing the possible ancillary benefits and countervailing risks. However, highly speculative or minor consequences may not be worth further formal analysis. Analytic priority should be given to those ancillary benefits and countervailing risks that are important enough to potentially change the rank ordering of the main alternatives in the analysis. In some cases, the mere consideration of these secondary effects may help in the generation of a superior regulatory alternative with strong ancillary benefits and fewer countervailing risks. For instance, a recent study suggested that weight-based, fuel-economy standards could achieve energy savings with fewer safety risks and employment losses than would occur under the current regulatory structure.[80]

OMB's reiterated its position on this issue in draft guidance that it issued in 2017, which stated that "[t]he consideration of co-benefits, including the co-benefits associated with reduction of particulate matter, is consistent with standard accounting practices and has long been required under OMB Circular A-4."[81]

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[80] Office of Management and Budget (OMB), *Circular A-4: Regulatory Analysis*, 2003, p. 26.
[81] Office of Management and Budget (OMB), *2017 Draft Report to Congress on the Benefits and Costs of Federal Regulations and Agency Compliance with the Unfunded Mandates Reform Act*, 2017, p. 13.

In addition, EPA uses filterable particulate matter emitted by coal- and oil-fired EGUs as a surrogate for non-mercury metal air toxics because these metals are closely associated with filterable particulates.[82] Therefore, controls that reduce filterable particulate matter from coal- and oil-fired EGUs are responsible for achieving reductions of these non-mercury metals. As a factual matter, control of filterable particulates emitted from EGUs is integrally linked to control of most metal toxics emitted by the same facilities.

V. Summary

Almost 20 years after EPA first found it "appropriate and necessary" to limit mercury and other air toxics emitted by coal- and oil-fired EGUs (and reaffirmed it twice), the Agency now proposes to withdraw the finding. In doing so, EPA presents no new scientific assessment that air toxics emitted by EGUs no longer threaten public health and the environment. Instead, EPA presents a drastically scaled-back approach to assessing the benefits from reducing EGU air toxic emissions. In doing so, EPA conducts a cost-benefit analysis where the Agency contrasts only one narrow slice of monetized benefits against an outdated and demonstrably wrong monetized set of control costs. As a practical matter and with no prior precedent, EPA is now dismissing all other benefits of MATS that it does not assign a dollar value to, which by implication is the same as assigning them a value of zero dollars.

Furthermore, EPA inexplicably ignores standard good accounting practice and federal OMB guidance by dismissing MATS co-benefits that it has itself recognized may be relied upon by states in developing strategies to achieve compliance with other Clean Air Act requirements.

By basing its proposal to withdraw its previous "appropriate and necessary" finding on a narrowly constrained cost-benefit analysis that is incapable of adequately considering all the impacts of the HAPs covered by MATS, EPA fails to provide an informed analysis. In reviewing a more complete and extensive record of the range of benefits achievable by the MATS rule, and recognizing the actual historical costs of MATS compliance, we conclude that EPA lacks a proper foundation for withdrawing its long-standing "appropriate and necessary" finding.

[82] 77 Fed. Reg. 9304-9513 (February 16, 2012), at 9402.

Andover Technology Partners 978-683-9599
Consulting to the Air Pollution Control Industry

Update of the Cost of Compliance with MATS – Ongoing Cost of Controls

White Paper

By

James E. Staudt, Ph.D., CFA
Andover Technology Partners
April 15, 2019

James E. Staudt, Ph.D., CFA

Purpose

The purpose of this effort is to estimate annual operating costs associated with the Mercury and Air Toxic Standards (MATS). In effect, what the impact would be in terms of operating costs if MATS was rescinded. These operating costs include:

1. Operating and maintenance costs associated with Activated Carbon Injection (ACI) – this includes the cost of activated carbon as well as any energy used for the systems, waste disposal and maintenance costs.
2. Operating and maintenance costs associated with Dry Sorbent Injection (DSI) - this includes the cost of lime or trona as well as any energy used for the systems, waste disposal and maintenance costs.
3. Operating and maintenance costs associated with chemical injection – this would include the costs associated with bromine (or other oxidizing chemicals) as well as chemicals used to control reemission of mercury in wet scrubbers
4. Operating and maintenance costs associated with monitoring Hg and HCl

Although there were some scrubber and Electrostatic Precipitator (ESP) upgrades performed for MATS, these generally do not result in an increase in operating or maintenance costs. Also, any fabric filter retrofits performed for MATS (which were few in number) cannot be "undone". Therefore, rescinding the MATS rule will not make a change in the operating costs for those units that retrofit fabric filters in response to MATS.

This methodology will estimate the costs that were incurred in 2018 as that is the last full year of operating data. This update is important for a number of reasons.

1. The complexion of the coal utility fleet has changed substantially over the past few years, as many units, particularly unscrubbed units, have been retired. This impacts the need for consumables such as activated carbon which is used mostly on unscrubbed boilers.
2. Those facilities that have continued to operate are often operating at a lower capacity factor than they were a few years ago, which also impacts the operating costs.
3. There is more data available on the operation of air pollution control and monitoring technologies than there was during the previous estimate, making current estimates more accurate and reflective of actual costs being incurred.

In this effort the operating costs will be built up from a "bottom up" approach. This is done by looking at the total installations of various technologies and determining the associated operating cost. This approach will not examine any costs associated with changes in the fleet fuel mix that might be attributable to MATS. First, as determined by the Department of Energy, the primary reason for the increased use of natural gas versus coal was sustained low natural gas prices.[1] As a result MATS had a very small impact on decisions to increase use of natural gas for power generation. Another impact

[1] United States Department of Energy, "Staff Report to the Secretary on Electricity Markets and Reliability", August 2017, pg 13.

that is not explored here is the effect of MATS retirements. While there were a substantial number of coal retirements during the time period leading up to the MATS compliance dates and even coincident with MATS dates, most of these facilities were uneconomical even without MATS, in part due to the competition from natural gas and other generating technologies, and were destined for retirement.

Also, in examining the impact of MATS versus state rules requiring mercury control it was determined that only those facilities that did not already have state rules in place would be impacted with regard to mercury monitoring and controls in the event MATS were rescinded. On the other hand, these facilities would be impacted with respect to other MATS emissions requirements.

Finally, some facilities use more capital intensive technologies, such as capture membranes, that have low operating costs. These facilities are also relatively few in number. Because of the small numbers and the low operating costs associated with these technologies, they will not be addressed in this study.

The US Environmental Protection Agency's 2018 Air Markets Program Data (AMPD) was used to determine the pollution controls installed, the level of generation, the capacity,[2] the number of units and the number of chimneys.[3] This is shown in Table 1. For unscrubbed facilities, it was assumed that these facilities had ACI for mercury controls even if no mercury controls were reported. Also, if DSI was reported for a facility that also had a scrubber, it was assumed that the DSI system was for SO3 rather than HCl because the scrubbers were adequate for HCl compliance (below 0.20 lb/MMBtu SO2). Besides, these are few in number and will not impact the total by much. For the purpose of this effort the operating costs for mercury controls on facilities in states with mercury rules that predate MATS and would stay regardless of rescinding of MATS are shown, but are subtracted from the costs that would be saved in the event of rescinding of MATS.

Operating and Maintenance Costs Associated with ACI installed for MATS Compliance

Operating costs for ACI include variable operating costs associated with sorbent consumption (VOMR), waste disposal, if needed (VOMW), power consumption (VOMP) and fixed operating and maintenance costs (FOM). Variable operating costs for sorbent consumption for any application will vary based upon the conditions. Table 2 shows estimated VOMR for activated carbon for a range of applications.

The costs therefore range from about 0.10 mill/kWh to about 1.0 mill/kWh. The most costly conditions are those where there is SO_3 conditioning or high sulfur coal. These, fortunately, are not the most common situations. The more common situations utilize lower treatment rates, resulting in costs on the order of 0.30 to 0.70 mills/kWh or less.

Variable operating costs will also include disposal costs for waste. Activated carbon will increase the amount of fly ash that must be disposed of. In many cases it does not adversely impact fly ash sales because suppliers have developed "concrete friendly" carbons and are also able to utilize much lower treatment rates than in the past. Trends have been for increases in fly ash utilization, despite more

[2] Capacity in MW was estimated as dividing the reported rated heat input in MMBtu/hr by 10.5 (assuming a heat rate of 10.5 million Btu/MWhr

[3] Because of common chimneys at some plants, there are fewer chimneys than electric generating units.

widespread use of activated carbon. In fact, in 2017 64% of coal combustion products (CCPs) were reutilized, a record.[4] If fly ash is sold, there is no waste impact. If fly ash is disposed ofit will increase the cost of disposal in proportion to the carbon used. If disposal cost is $50/ton ($0.025/lb) and carbon costs around $1/lb, disposal cost is roughly 2.5% of the cost of purchasing the carbon. In light of the increased utilization of fly ash that will mitigate the likelihood of disposal, this assumption is a conservative one.

Table 1. Control Technologies

	MW rating	# of chimneys	# of units	Total MWh
No State Hg Rules (total)	**244,150**	**387**	**438**	**1,001,117,603**
ACI	5,475	13	14	12,407,787
ACI	18,668	37	38	82,057,285
ACI DSI	6,829	8	9	29,613,640
FF	3,949	8	16	16,282,022
FF PAC	10,067	17	17	44,922,314
FF PAC DSI	1,792	3	3	9,417,212
Scrubber, ESP no ACI	67,893	87	106	247,908,135
Scrubber, ESP ACI	15,555	24	24	71,234,233
Scrubber, ESP, ACI, DSI	447	1	1	1,373,206
Scrubber, FF no ACI	67,137	115	127	275,712,012
Scrubber, FF ACI	42,796	66	73	204,409,791
Scrubber, FF, ACI, DSI	741	2	2	3,128,205
HS ACI	446	2	3	742,376
HS ACI	637	1	1	979,761
HS ACI FF	813	1	1	427,082
HS ACI FF	906	2	3	502,544
State Hg Rules (total)	**61,169**	**116**	**125**	**215,058,853**
ACI	4,408	10	12	14,118,051
ACI	5,771	14	15	17,339,033
ACI DSI	3,571	5	8	10,480,991
FF	1,197	7	8	3,632,220
FF PAC	250	1	1	103,496
FF PAC DSI	751	2	2	2,753,440
Scrubber, ESP no ACI	18,329	28	33	71,270,330
Scrubber, ESP ACI	6,577	9	11	18,187,734
Scrubber, FF no ACI	7,781	22	17	19,946,891
Scrubber, FF ACI	11,881	16	16	55,786,497
HS ACI	274	1	1	465,408
HS ACI	380	1	1	974,763
Grand Total	**305,319**	**503**	**563**	**1,216,176,456**

[4] American Coal Ash Association, "Coal Ash Recycling Reaches Record 64 Percent Amid Shifting Production and Use Patterns", November 13, 2018, https://www.acaa-usa.org/Portals/9/Files/PDFs/Coal-Ash-Production-and-Use-2017.pdf

Table 2. The variable operating cost of sorbent for current, state of the art, commercial carbons.[5]

Coal-Fired Site	Product	AQCS	Fuel	DSI	FGC	% Removal Hg	mill/Kwh
1	DARCO® Hg-LH EXTRA SP	SCR/FF	Low Chlorine Subbit.	None	None	94	0.086
2	DARCO® Hg-LH EXTRA SP	CS-ESP	Local W.Subbit	None	None	80	0.222
3	DARCO® Hg-LH EXTRA SP	CS-ESP	Local W.Subbit	None	None	80	0.244
4	DARCO® Hg-LH EXTRA SP	CS-ESP	Low Chlorine Subbit.	None	None	87	0.328
5	DARCO® Hg-LH EXTRA TR	CS-ESP/wFGD	High Sulfur Bit.	Calcium-based	None	82	0.375
6	DARCO® Hg-LH EXTRA TR	CS-ESP	PRB/Bit. Blend	Sodium-based	None	88	0.663
7	DARCO® Hg EXTRA	CS-ESP	Low Chlorine Subbit.	None	SO_3 (6ppm)	90	0.789
8	DARCO® Hg-LH EXTRA SR	CS-ESP	PRB	None	SO_3 (7ppm)	90	0.872
9	DARCO® Hg EXTRA SR	SNCR/ESP/wFGD	High Sulfur Bit.	None	None	96	0.980

Other variable operating costs include energy, estimated as about $0.01/MWh from the Sargent & Lundy memo on mercury control. [6]

Fixed operating costs for operation and maintenance are estimated at 1.4% of capital cost, including overhead, per the Sargent & Lundy memo. ACI capital costs are assumed to be $15/kW on average.

Using these factors and the information in Table 1, the costs for operating ACI systems are shown in Table 3. This is a significant drop from what was estimated only about two years ago. The reason is twofold. First, generation levels for facilities that are equipped with ACI are much lower than they were. Second, facility owners and mercury sorbent suppliers have optimized their operation and sorbent products to reduce the amount of material that is needed.

Table 3: Estimated operating costs for ACI systems

	VOMR	VOMW	VOMP	FOM	Total
ACI in States without Hg Rules	$99,757,000	$2,494,000	$4,729,000	$22,666,000	$129,646,000
ACI in states with Hg rules	$29,897,000	$746,000	$1,239,000	$7,364,000	$39,246,000
Total	$129,654,000	$3,240,000	$5,968,000	$30,030,000	$168,892,000

Operating and Maintenance Costs for DSI Systems installed for MATS compliance

DSI systems potentially include trona as well as lime injection systems. VOMR is estimated by assuming roughly 2 lb of lime or trona reagent per lb of total acid gas (using SO_2 since it is usually present in much larger quantities than HCl), an average 0.50lb SO_2/MMBtu coal[7], average heat rate of 10,500 Btu/kWh,

[5] Fessenden, J., Satterfield, J., "Cost Effective Reduction of Mercury Using Powder Activated Carbon Injection", March 2, 2017

[6] Sargent & Lundy, "IPM Model – Updates to Cost and Performance for APC Technologies Mercury Control Cost Development Methodology Final", March 2013, Project 12847-002, Systems Research and Applications Corporation

[7] The average weighted outlet SO_2 emission rate for DSI equipped units was 0.20 lb/MMBtu. Assuming an average SO_2 capture rate of 60% (about midway between 50% and 70% - the typical rates for ESP or FF equipped units, respectively) results in and uncontrolled rate of 0.50 lb/MMBtu

and a cost of hydrated lime or trona equal to $150/short ton. [8] It should be noted that for units that fire coal from the Powder River Basin (PRB), the lime or trona consumption would be much less and in many cases no lime or trona would be necessary to be added – the DSI system is added primarily as a precaution.

Variable operating costs will also include disposal costs for waste. DSI will increase the amount of fly ash that must be disposed of. Generally, it does not adversely impact fly ash sales because the most commonly used reagent is lime, which will generally improve fly ash marketability. If fly ash is disposed of, it will increase the cost of disposal in proportion to the lime used. Disposal cost is estimated at $50/ton. Since 64% or more of the industry's coal ash is recycled, it is reasonable to assume that 36% of the facilities already need to dispose of waste.

Other variable operating costs include energy, estimated as about $0.39/MWh from the Sargent & Lundy memo on DSI. [9]

Fixed operating costs for operation and maintenance are estimated at 1.4% of capital cost, including overhead, per the Sargent & Lundy memo. The Sargent & Lundy memo includes two additional operators for a DSI system, which would increase operating costs from what is assumed. This is not correct. DSI systems are simple systems that do not require additional operators. In any event, the impact of this is small compared to the VOMR.

Using these factors, the estimated costs for operating DSI systems is shown in Table 4

Table 4. Estimated operating costs for DSI systems

	VOMR	VOMW	VOMP	FOM	Total
DSI operating costs	$16,600,000	$5,608,000	$21,604,000	$4,789,000	$53,812,000

This is lower than previously estimated, largely because the previous estimate was based upon an assumed SO_2 rate that turned out to be far too high as most DSI systems are in fact on lower sulfur coal units. Other factors include lower generation rates and retirements.

Operating and Maintenance Costs for Other technologies installed for MATS compliance

Chemical additives for Hg compliance add operating cost. Hg oxidation and scrubber additives for mercury control were estimated in the 2015 ICAC Market forecast[10] to be in the range of $80-$100 million for the years 2018-2019. It was estimated at a cost of $90 million per year. On the other hand,

[8] Treatment rate from: Fitzgerald, H., "Hydrated Lime DSI - Solution for Acid Gas Control (SO3, HCl, and HF)", MARAMA /ICAC SO2/HCl CONTROL TECHNOLOGIES WEBINAR, July 19, 2012

Also, USGS 2018 Minerals Commodity Summary , shows 2018 cost of lime hydrate of $150/metric ton, or about $135 per short ton. $150/short ton is than assumed in this evaluation. Trona had similar costs.

[9] Sargent & Lundy, "IPM Model – Updates to Cost and Performance for APC Technologies, Dry Sorbent Injection for SO2 Control Cost Development Methodology – Final", March 2013, Project 12847-002, Systems Research and Applications Corporation

[10] Institute of Clean Air Companies, 2015 Annual Market Study, pp 19-20

this needs to be adjusted for revised generation levels versus the assumptions used at that time. In that previous estimate a total coal generation level of about 1 billion MWh[11] was assumed for units with wet FGD, versus 728 million MWh actually experienced on units with wet FGD systems 2018. Therefore, the $90 million value previously assumed is adjusted for the lower generation to about $66 million, shown in Table 5. This is distributed between those states with state rules versus those without on the basis of generation with wet FGD in those states.

Table 5. Operating costs for Chemical Addition

States without Hg rules	$52,858,000
States with Hg rules	$12,675,000
Total	$65,533,000

Operating and Maintenance Costs of Hg CEMS

Operating costs of Hg CEMS include the labor and materials for operating and maintaining the equipment as well as the cost of Relative Accuracy Test Audits and other compliance requirements of the CEMS. This was estimated as roughly $40,000 per year[12] and with 387 chimneys in states without Hg rules and 116 chimneys in states with Hg rules. This results in costs of shown in Table 6. The $40,000/year estimate is lower than previous estimates and is based upon more recent, published information.

Table 6. Operating costs for Hg CEMS

States without Hg rules	$15,480,000
States with Hg rules	$4,640,000
Total	$20,120,000

[11] 998,749,500 MWh, this was taken from Andover Technology Partners' proprietary model which assumed a 70% capacity factor.

[12] Estimated from slide 20 Wilber, K., "EGU MATS Compliance - Hg CEM Systems Challenges and Opportunities", Electric Utility and Energy Confernce, February 16-18, 2015, San Diego

Operating and Maintenance Costs of HCl monitoring

Scrubbed units for the most part can demonstrate compliance with the HCl requirements of MATS maintaining adequately low SO_2 emission rates. Therefore, for most scrubbed units there is no additional monitoring need for HCl. There are 133 chimneys on unscrubbed units. Most facilities will comply through periodic stack tests with EPA Method 26A. Since, like a PM test it is an extractive sample, this is estimated to cost in the same range as a PM stack test (which is also performed quarterly at an estimated price of $8500/time[13] or $34,000 per year). This equates to $4.5 million per year in total as shown in Table 7.

Table 7. Operating and Maintenance costs of HCl Monitoring

Total	4,522,000

Operating costs associated with increased PM measurement frequency

For those facilities that do not already have a PM CEMS due to Consent Decree or other requirement, facilities have had to increase PM measurement frequency to quarterly measurements as a result of MATS. Some facilities may already have quarterly measurement requirements that are imposed by the state. Others may only have annual requirements. It is not possible to determine the incremental cost of increased PM measurement due to MATS frequency industrywide because of the use of PM CEMS under Consent Decrees and other factors. However, like Hg and HCl measurement costs, it will be substantially less than the cost of controls.

Total possible cost savings industrywide in the event of MATS being rescinded

Total annual operating costs for all MATS technologies that would be reduced or eliminated in the event MATS was rescinded are shown in Table 8. These do not include those costs associated with mercury controls and monitoring in those states that have Hg rules that predated MATS and would stay in effect regardless of whether or not MATS was rescinded. As shown, the total impact is on the order of $203 million. It is true that this does not account for the cost associated with PM or non-mercury metals measurements. However, these should be small compared to the $203 million for other costs. The impact on generation costs nationwide would average only about $0.17/MWh for energy generated by coal-fired power plants, which accounts for less than one-third of all generation.[14]

[13] $8500 per quarter, from https://www.powermag.com/simplify-mats-compliance-particulate-matter-continuous-emission-monitors/?printmode=1

[14] In 2018 total generation from coal was only 27.4% of total generation https://www.eia.gov/tools/faqs/faq.php?id=427&t=3

Table 8. Total Annual Operating Costs for MATS technologies.

ACI in States without Hg Rules	$129,646,000
DSI	$53,812,000
Hg CEMS (no state rules)	$15,480,000
HCl	$4,522,000
Scrubber Chemicals (no state Hg rules)	$52,858,345
Total incremental cost of MATS	$203,460,000
Total 2018 MWh gross – all electric utility coal units	1,216,176,456*
$/MWh gross savings	$0.17*
Note: Not included in the above are mercury control and monitoring costs in states with pre-existing mercury rules that would remain in effect regardless of MATS * Net generation from coal in 2018 is reported as 1,146,000,000 MWh, which would result in a cost of $0.18/MWh.	