IEc

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.

TABLE OF CONTENTS

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

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.

[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.

[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

[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.

REFERENCES

Bienkowski, Brian, *Cleaner Bluefish Suggest Coal Rules Work,* Scientific American (Jul. 20, 2015), *available at* http://www.scientificamerican.com/article/cleaner-bluefish-suggest-coal-rules-work/.

Carrington, C.D., Montwill, B., and Bolger, P.M. 2004. An Interventional Analysis for the Reduction of Exposure to Methylmercury from the Consumption of Seafood by Women of Child-bearing Age. *Center for Food Safety and Applied Nutrition, U.S. Food and Drug Administration*.

Chan, H.M., A.M. Scheuhammer, A. Ferran, C. Loupelle, J. Holloway, and S. Weech. 2003. Impacts of mercury on freshwater fish-eating wildlife and humans. *Human and Ecological Risk Assessment* 9(4):867-883.

Chen, H.Z. and S.R. Cosslett. 1998. Environmental Quality Preference and Benefit Estimation in Multinomial Probit Models: A Simulation Approach. *American Journal of Agricultural Economics* 80(3): 512-520.

Confederated Tribes of the Colville Reservation, Spokane Tribe of Indians, U.S. Department of the Interior, and State of Washington. 2012. Injury Assessment Plan for the Upper Columbia River Site, Washington. Prepared for the Upper Columbia River Trustee Council. May.

Connelly, N.A., B.A. Knuth, and C.A. Bisogni. 1990. New York Statewide Angler Survey 1988. Prepared by the New York State Department of Environmental Conservation, Division of Fish and Wildlife, Albany, NY. April.

Connelly, N.A., B.A. Knuth, and C.A. Bisogni. 1992. Effects of the Health Advisory and Advisory Changes on Fishing Habits and Fish Consumption in New York Sport Fisheries. Report for the New York Sea Grant Institute Project No. R/FHD-2-PD. Human Dimensions Research Unit, New York DNR. Series No 92-9. September.

Connelly, N.A., B.A. Knuth, and T.L. Brown. 1996. "Sportfish Consumption Patterns of Lake Ontario Anglers and the Relationship to Health Advisories." North American Journal of Fisheries Management 16:90-101.

Cristol, D.A., Brasso, R.L., Condon, A.M., Fovargue, R.E., Friedman, S.L., Hallinger, K.K., Monroe, A.P., and A.E. White. 2008. The movement of aquatic mercury through terrestrial food webs. *Science* 320:335.

Cross, F.A., Evans, D.W. and Barber, R.T., 2015. Decadal declines of mercury in adult bluefish (1972–2011) from the mid-Atlantic coast of the USA. *Environmental science & technology*, 49(15), pp.9064-9072.

Driscoll, C.T., Mason, R.P., Chan, H.M., Jacob, D.J. and Pirrone, N., 2013. Mercury as a global pollutant: sources, pathways, and effects. *Environmental science & technology*, 47(10), pp.4967-4983.

Driscoll, C.T., Han, Y.J., Chen, C.Y., Evers, D.C., Lambert, K.F., Holsen, T.M., Kamman, N.C. and Munson, R.K., 2007. Mercury contamination in forest and freshwater ecosystems in the northeastern United States. *BioScience*, 57(1), pp.17-28.

Eisler, R. 2000. Handbook of Chemical Risk Assessment: Health Hazards to Humans, Plants and Animals, Volume I: Metals. Lewis Publishers, Boca Raton, London, New York, Washington, DC.

EPRI (Electric Power Research Institute). 2004. Atmospheric Mercury Research Update. Palo Alto, CA. 1005500.

Evers, D.C., Wiener, J.G., Driscoll, C.T., Gay, D.A., Basu, N., Monson, B.A., Lambert, K.F., Morrison, H.A., Morgan, J.T., Williams, K.A. and Soehl, A.G., 2011. Great Lakes mercury connections: the extent and effects of mercury pollution in the Great Lakes region. Report BR1, 18.

Fitzgerald, W. F., Engstrom, D. R., Mason, R. P., & Nater, E. A. 1998. The case for atmospheric mercury contamination in remote areas. *Environmental science & technology*, *32*(1), 1-7.

Giang, A., & Selin, N. E. 2016. Benefits of mercury controls for the United States. *Proceedings of the National Academy of Sciences*, *113*(2), 286-291.

Hagen, D.A., J.W. Vincent, and P.G. Welle. 1999. Economics Benefits of Reducing Mercury Deposition in Minnesota. Report to the Minnesota Pollution Control Agency and the Legislative Commission on Minnesota Resources. June.

Harris, R.C., Rudd, J.W., Amyot, M., Babiarz, C.L., Beaty, K.G., Blanchfield, P.J., Bodaly, R.A., Branfireun, B.A., Gilmour, C.C., Graydon, J.A. and Heyes, A., 2007. Whole-ecosystem study shows rapid fish-mercury response to changes in mercury deposition. *Proceedings of the National Academy of Sciences*, 104(42), pp.16586-16591.

Hauber, A. B. and G. R. Parsons. 2000. The Effect of Nesting Structure Specification on Welfare Estimation in a Random Utility Model of Recreation Demand: An Application to the Demand for Recreational Fishing. *American Journal of Agricultural Economics* 82(3): 501-514.

Industrial Economics, Inc. (IEc). 2017. Onondaga Lake Natural Resource Damage Assessment Restoration Plan and Environmental Assessment. Draft Report prepared for the United States Fish and Wildlife Service and the State of New York Department of Environmental Conservation. April.

Jakus, P. M. and W.D. Shaw. 2003. Perceived Hazard and Product Choice: An Application to Recreational Site Choice. *The Journal of Risk and Uncertainty* 26(1): 77-92.

Jakus, P., M. McGuinness, and A. Krupnick. 2002. The Benefits and Costs of Fish Consumption Advisories for Mercury. Discussion Paper 02-55, October.

Jakus, P.M., D. Dadakas, and J.M. Fly. 1998. Fish consumption advisories: Incorporating angler-specific knowledge, habits, and catch rates in a site choice model. *American Journal of Agricultural Economics* 80(5), Proceedings Issue: 1019-1024.

Jakus, P.M., M. Downing, M.S. Bevelhimer, and J.M. Fly. 1997. Do sportfish consumption advisories affect reservoir anglers' site choice? *Agricultural and Resource Economics Review* 26: 196–204.

Knightes, C.D., Sunderland, E.M., Barber, M.C., Johnston, J.M. and Ambrose, R.B., 2009. Application of ecosystem-scale fate and bioaccumulation models to predict fish mercury response times to changes in atmospheric deposition. *Environmental Toxicology and Chemistry*, 28(4), pp.881-893.

Knuth, B.A., N.A. Connelly, and M.A. Shapiro. 1993. Angler Attitudes and Behavior Associated with Ohio River Health Advisories. Human Dimensions Research Unit, Department of Natural Resources, New York State College of Agriculture and Life Sciences, A Statutory College of the State University, Fernow Hall, Cornell University, Ithaca, NY.

Krabbenhoft, D.P., & Sunderland, E.M. 2013. Global change and mercury. *Science*, 341(6153), 1457-1458.

Lee, C.S., Lutcavage, M.E., Chandler, E., Madigan, D.J., Cerrato, R.M. and Fisher, N.S., 2016. Declining mercury concentrations in bluefin tuna reflect reduced emissions to the North Atlantic Ocean. *Environmental science & technology*, 50(23), pp.12825-12830.

MacDonald, H.F. and K.J. Boyle. 1997. Effect of a Statewide Sport Fish Consumption Advisory on Open-Water Fishing in Maine. *North American Journal of Fisheries Management* 17(3): 687-695.

MacNair, D.J. and W.H. Desvousges. 2007. The economics of fish consumption advisories: Insights from revealed and stated preference data. *Land Economics* 83 (4): 600–616, ISS 0023-7639; E-ISS 1543-8325.

Mason, R.P., Choi, A.L., Fitzgerald, W.F., Hammerschmidt, C.R., Lamborg, C.H., Soerensen, A.L. and Sunderland, E.M., 2012. Mercury biogeochemical cycling in the ocean and policy implications. Environmental research, 119, pp.101-117.

Mason, R.P., J.-M. Laporte, and S. Andres. 2000. Factors controlling the bioaccumulation of mercury, methylmercury, arsenic, selenium, and cadmium by freshwater invertebrates and fish. *Archives of Environmental Contamination and Toxicology* 38:283-297.

Montgomery, M. and M. Needelman. 1997. The welfare effects of toxic contamination in freshwater fish. *Land Economics* 73(2): 212-223.

Morey, E.R. and W.S. Breffle. 2006. Valuing a change in a fishing site without collecting characteristics data on all fishing sites: a complete but minimal model. *American Journal of Agricultural Economics* 88(1): 150–161.

NOAA (National Oceanic and Atmospheric Administration). 2019. Annual Commercial Landing Statistics. Available online at: https://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings/index.

NOAA (National Oceanic and Atmospheric Administration). 2019. Great Lakes Commercial Fishery Landings. Available online at: https://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/other-specialized-programs/great-lakes-landings/index.

Pacyna, E.G., Pacyna, J.M., Sundseth, K., Munthe, J., Kindbom, K., Wilson, S., Steenhuisen, F. and Maxson, P., 2010. Global emission of mercury to the atmosphere from anthropogenic sources in 2005 and projections to 2020. Atmospheric Environment, 44(20), pp.2487-2499.

Parsons, G.R., T. Tomasi, and P. Jakus. 1999. A comparison of welfare estimates from four models for linking seasonal recreational trips to multinomial models of site choice. *Journal of Environmental Economics and Management* 38(2): 143-157.

Rosenberger, R. 2016. Recreation Use Values Database (RUVD). Corvallis, OR: Oregon State University, College of Forestry. Available online at: http://recvaluation.forestry.oregonstate.edu/. Accessed 7/11/2016.

Scheuhammer, A.M. and M.B. Sandheinrich. 2008. Recent advances in the toxicology of methylmercury in wildlife. *Ecotoxicology* 17(2):67-68.

Seigneur, C., K. Vijayaraghavan, K. Lohman, P. Karamchandani, and C. Scott. 2004. Global source attribution for mercury deposition in the United States. *Environmental Science and Technology* 38(2):555-569.

Selin, N.E., D.J. Jacob, R.J. Park, R.M. Yantosca, S. Strode, L. Jaegle, and D. Jaffe. 2007. Chemical cycling of atmospheric mercury: Global constraints from observations. *Journal of Geophysical Research* 112(D2).

Selin, N.E., Sunderland, E.M., Knightes, C.D. and Mason, R.P., 2010. Sources of mercury exposure for US seafood consumers: implications for policy. *Environmental health perspectives*, 118(1), pp.137-143.

Shimshack, J., Ward, M., and Beatty, T. 2007. Mercury advisories: Information, education, and fish consumption. *Journal of Environmental Economics and Management.* Volume 53(2), p. 158 – 179.

Silverman, W.M. 1990. Michigan's Sport Fish Consumption Advisory: A Study in Risk Communication. Masters thesis. University of Michigan, Ann Arbor.

Swain, E. B., Engstrom, D. R., Brigham, M. E., Henning, T. A., & Brezonik, P. L. 1992. Increasing rates of atmospheric mercury deposition in midcontinental North America. *Science*, *257*(5071), 784-787.

Tang, C., M.D. Heintzelman, and T.M. Holsen. 2018. Mercury pollution, information, and property values. *Journal of Environmental Economics and Management* 92: 418-432.

Texas General Land Office; Texas Parks and Wildlife Department; Texas Natural Resource Conservation Commission; National Oceanic and Atmospheric Administration; and the U.S. Fish and Wildlife Service, U.S. Department of the Interior. 2001. Damage Assessment and Restoration Plan and Environmental Assessment for the Point Comfort/Lavaca Bay NPL Site Recreational Fishing Service Losses. June.

Tilden, J., Hanrahan, L., Anderson, H., Palit, C., Olson, J., Mac Kenszie, W., and the Great Lakes Sport Fish Consortium. 1997. Health Advisories for Consumers of Great Lakes Sport Fish: Is the Message Being Received? *Environmental Health Perspectives,* Volume 105(12).

U.S. BEA (Bureau of Economic Analysis). 2013. RIMS II. An essential tool for regional developers and planners.

U.S. EPA. 1997. Mercury study report to Congress. Volume I: Executive Summary. Office of Air Quality Planning and Standards, Office of Research and Development. EPA-452/R-97-003. December.

U.S. EPA. 2005. Regulatory impact analysis of the Clean Air Mercury Rule. EPA-425/R-05-003. March.

U.S. EPA. 2017. EPA-FDA Advice about Eating Fish and Shellfish. https://www.epa.gov/fish-tech/2017-epa-fda-advice-about-eating-fish-and-shellfish

U.S. EPA. 2018. "EPA Releases Proposal to Revise MATS Supplemental Cost Finding and "Risk and Technology Review" News Releases from Headquarters Air and Radiation. Found on April 8, 2019 at https://www.epa.gov/newsreleases/epa-releases-proposal-revise-mats-supplemental-cost-finding-and-risk-and-technology. December 28.

U.S. EPA. 2019. 40 CFR Part 63 [EPA–HQ–OAR–2018–0794; FRL–9988–93–OAR], RIN 2060–AT99 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. February 7.

United Nations Environment Programme (UNEP). 2019. Global Mercury Assessment 2018. UN Environment Programme, Chemicals and Health Branch, Geneva, Switzerland.

United States Environmental Protection Agency. Health Effects of Exposures to Mercury. https://www.epa.gov/mercury/health-effects-exposures-mercury

United States Fish and Wildlife Service (USFWS). 2016. Net Economic Values for Wildlife-Related Recreation in 2011. Addendum to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Report 2011-8. Available online at: https://digitalmedia.fws.gov/cdm/ref/collection/document/id/2125. Accessed 3/22/2019.

USFWS and Stratus Consulting (USFWS). 1999. Recreational Fishing Damages from Fish Consumption Advisories in the Waters of Green Bay. Prepared for U.S. Fish and Wildlife Service, U.S. Department of Justice, and U.S. Department of Interior. Stratus Consulting I

USFWS and U.S. Census Bureau. 2018. 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: State Reports. U.S. Department of the Interior Fish and Wildlife Service and U.S. Department of Commerce Census Bureau

Vena, J.E. 1992. Risk, Perception, Reproductive Health Risk and Consumption of Contaminated Fish in a Cohort of New York State Anglers. New York State Angler Study Year One Progress Report.

Vijayaraghavan, K., Levin, L., Parker, L., Yarwood, G. and Streets, D., 2014. Response of fish tissue mercury in a freshwater lake to local, regional, and global changes in mercury emissions. *Environmental toxicology and chemistry*, 33(6), pp.1238-1247.

West, P.C., J.M. Fly, R. Marans, F. Larkin, and D. Rosenblatt. 1993. 1991-92 Michigan Sport Angler Fish Consumption Study. University of Michigan, Natural Resource Sociology Research Lab Technical Report No. 6.

Wiener, J.G. and D.J. Spry. 1996. Toxicological significance of mercury in freshwater fish. In: W.N. Beyer, G.H. Heinz, and A.W. Redmon-Norwood (eds.). Environmental Contaminants in Wildlife. Lewis Publishers, Boca Raton, FL.

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

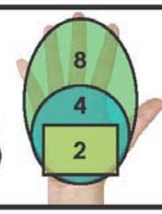
See page 2 to learn about *MI Servings

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.

1

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.

3

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

4

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.

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

6

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

7