Methods for the Development of Fish Consumption Advisories in the State of New Jersey

Prepared by:

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1.0 Introduction

Fish consumption advisories are public health-protective recommendations for the frequency of consumption of recreationally caught fish that may contain environmental contaminants. These advisories aim to protect public health while also balancing the health benefits of consuming fish, which are a low-fat, high-quality source of protein and nutrients. Contaminants such as mercury or polychlorinated biphenyls (PCBs) can bioaccumulate in fish and pose a health risk to the public. Fish consumption advisories provide recommendations to help the public decide on where to fish and which fish are the best choice for consumption. They are based on scientific research into the occurrence, bioaccumulation, human health effects of contaminants, and consumption patterns for recreationally caught fish.

The State of New Jersey develops statewide, region-wide, and water body-specific consumption advisories for fish harvested from NJ waters based upon data collected through the historic monitoring programs, research projects conducted by the New Jersey Department of Environmental Protection (NJDEP), data from other partner agencies or neighboring states, and the Routine Monitoring Program for Toxics in Fish (Routine Monitoring Program). After approximately 25 years of non-routine monitoring, a routine monitoring program was established and initiated in 2002 to sample the state's waters on a rotating five-year cycle. The Toxics in Biota Committee (TIBC), an interagency group consisting of the NJDEP, New Jersey Department of Health (NJDOH), and the New Jersey Department of Agriculture (NJDA), develops and recommends fish consumption advisories for New Jersey, in addition to evaluating the current state of the science on contaminants in wildlife and making recommendations for research projects and management decisions as needed.

The TIBC Risk Subcommittee (hereafter referred to as the Risk Subcommittee), which consists of the chair of the TIBC, NJDEP toxicologist(s), and NJDOH environmental epidemiologist(s), develops the human health basis for advisories. Specifically, the Risk Subcommittee develops fish consumption trigger values, which are fish tissue concentrations above which unlimited (typically defined as daily meals of 8 oz., or 227 grams) consumption is not recommended. Trigger concentrations are developed for weekly, monthly, once every three months (sometimes referred to as "quarterly"), and yearly consumption frequencies. In addition, these triggers determine when consumption is not recommended ("Do Not Eat") if the yearly trigger concentration is exceeded. These triggers assume a standard meal size of 8 oz. (USEPA, 2000a) and are used along with fish tissue monitoring data to develop fish consumption advisories for individual species in specific water bodies or for larger areas of New Jersey, including regional and/or statewide advisories.

Chemical pollutants that are routinely sampled include mercury, PCBs,

dioxins/furans, and per- and polyfluoroalkyl substances (PFAS). Advisory triggers have also been developed for other contaminants, including pesticides such as DDT and its metabolites, lead, chlordane, and polycyclic aromatic hydrocarbons (PAHs). However, these contaminants do not typically "drive" advisories and are not routinely sampled unless there is a site-specific concern, or other environmental data suggesting they be tested. Currently, PCBs, mercury, dioxins/furans, and/or PFAS concentrations in fish tissue typically result in the most stringent advisories (i.e., least frequent consumption of a fish meal). Additionally, advisory trigger levels have been developed for three cyanotoxins that may be present in fish tissue when harmful algal blooms (HABs) occur.

While recognizing that contaminants may be present in recreationally caught fish, it is important to emphasize that fishing provides enjoyable and relaxing recreation, and that many people enjoy cooking and eating their own catch. Fish are an excellent source of protein, minerals, and vitamins, are low in fat and cholesterol, and play an important role in maintaining a healthy, well-balanced diet. Fish are also one of the few foods that are rich in the omega-3 fatty acids needed for proper development of the brain and nervous system in the fetus and infants and may reduce the risk of heart attack. Fish are an excellent substitute for other high protein foods that are higher in saturated fats and cholesterol, and health professionals recommend that fish be included in the diet, including the American Heart Association, which recommends people eat fish regularly. The development of fish advisories must therefore balance the risks and benefits of consuming locally caught fish.

2.0 Methodology

The procedures used to develop New Jersey fish consumption triggers and advisories are based on USEPA (2000a) guidance. In summary, consumption trigger concentrations are derived from toxicity factors (Reference Dose for non-cancer effects and Cancer Slope Factor for carcinogens) and exposure assumptions for the size of a fish meal, frequency of consuming a fish meal, and body weight. These triggers are developed for both a general population and high-risk population, defined as infants, children, pregnant women, nursing mothers, and women of childbearing age. Triggers for the high-risk group are intended to protect young children and developing fetuses during sensitive developmental stages. The general procedures described in Section 2.1 will be used to develop triggers and the resulting advisories for additional contaminants as needed.

Advisories are revised and released to the public semi-annually, or on an as-needed basis when data become available. Advisories may be regional or site-specific (Section 2.2) and are based on species that are commonly caught by recreational anglers for consumption. The New Jersey advisories also include a general recommendation to eat only the fillet portion of fish and avoid eating the whole fish, since parts of the fish other than muscle fillets may contain higher levels of organic contaminants. Additionally, it is recommended that cooking methods such as baking, broiling, frying, grilling, or steaming be used to allow the

fats and juices, which can contain higher levels of certain organic contaminants, to drain (NJDEP, 2021). Considerations and approaches for evaluation of monitoring data for concentrations of contaminants in fish tissue are discussed in Section 5.0, "*Procedures for Revising Fish Consumption Advisories,"* below.

2.1 Development of Consumption Triggers

Consumption triggers were developed for non-cancer effects and/or cancer risk, as appropriate, for each contaminant (see Section 3.0 for specific contaminant calculations). Trigger values assume the consumption of only the fillet portion of the fish, and do not consider the introduction of contaminants from other tissues. No adjustments are made for loss of the pollutant during preparation of the fish, and it is assumed that 100% of the chemical contaminant is absorbed into the body following ingestion. The equations and additional assumptions used in trigger development are provided below.

2.1.1 Triggers for non-cancer effects

Triggers for non-cancer effects were developed for non-carcinogenic contaminants. They were also developed for carcinogenic contaminants (e.g., PCBs) for which non-cancer effects may be more sensitive endpoints than cancer risk at the target risk level of 1×10^{-4} (1 in 10,000; see below) for the high-risk population.

Trigger concentrations for non-cancer effects were determined using chronic oral Reference Doses (RfDs) in Equation 1 below. The RfD is the daily dose at which adverse effects are not expected over a lifetime.

$$\text{Trigger for daily consumption } \left(\frac{\mu g}{g}\right) = \frac{\text{RfD } (\mu g/kg/day) \times \text{ body weight (kg)}}{\text{meal size (g/day)}}$$

Where:

RfD = chemical-specific Reference Dose (µg/kg/day)

Body weight = 70 kg (default adult; 154 pounds) for endpoints relevant to the general population

62 kg (adult female; 136 pounds) for high-risk populations if the RfD is based on a developmental endpoint

Meal size = 227 g (8 ounces)

Equation 1: Trigger value determination for non-cancer effects

The exposure factors used above are provided by USEPA (2000a) and assumed to apply to New Jersey residents[1]. Trigger concentrations for less frequent meal consumption were calculated by multiplying the trigger concentration for unlimited/daily consumption by the appropriate factor (e.g., 7 for weekly; 30.4 for monthly; 91 for once every three months; 365 for yearly).

In some cases, chemical-specific approaches were used to develop consumption triggers for non-carcinogenic effects, as for the following three contaminants:

PCBs: The lower end of the range for No Observed Adverse Effect Levels (NOAELs) for human reproductive and developmental effects was used instead of the RfD.

Cyanotoxins: Short-term RfDs were used instead of chronic RfDs because cyanotoxins are produced by HABs that last for several months or less, and exposure from contaminated fish is expected to be short-term.

Lead: No RfD is available because there is no known threshold for lead's adverse developmental effects. The triggers were based on the Centers for Disease Control blood lead reference value for children at the time when triggers were developed.

2.1.2 Triggers for cancer risk

In general, advisories for carcinogenic effects are based on the oral cancer slope factor (CSF) and a cancer risk level of 1 x 10^{-4} (1 in 10,000). This risk level was selected in order to balance the risks and benefits (Raatz et al., 2013) of eating fish. Equation 2 is used to develop triggers based on carcinogenic effects.

$$\text{Trigger for daily consumption } \left(\frac{\mu g}{g}\right) = \frac{\text{Cancer risk level} \times \text{body weight (kg)} \times 1000\ \mu g/mg}{\text{CSF (mg/kg/day)}^{-1} \times \text{meal size (g/day)}}$$

Where:

Cancer risk level = 10^{-4}
Body weight = 70 kg (default adult; 154 pounds)
CSF = chemical-specific cancer slope factor (mg/kg/day)$^{-1}$
Meal size = 227 g (8 ounces)
1000 µg/mg = unit conversion factor

Equation 2: Trigger value determination for cancer effects

[1] These are the USEPA (2000a) default recommendations for fish consumption advisories. USEPA has since updated the default adult body weight to 80.0 kg (USEPA, 2015) and plans to update their fish consumption advisory guidance in 2024/early 2025 (USEPA, 2024c). Updated USEPA exposure assumptions will be assessed and may be incorporated into future consumption triggers if they align with NJ specific parameters.

Exposure factors are provided by USEPA (2000a) and assumed to apply to New Jersey residents, and lifetime exposure duration is assumed[2].

As described for non-cancer effects above, trigger concentrations for less frequent meal consumption were calculated by multiplying the trigger concentration for unlimited/daily consumption by the appropriate factor (e.g., 7 for weekly; 30.4 for monthly; 91 for once every three months; 365 for yearly).

For dioxin and related compounds, an approach based on 1×10^{-4} (1 in 10,000) risk was not considered feasible because the lifetime cancer risk from background exposures to dioxin-like compounds was estimated to be about 1×10^{-3} (1 in 1,000), and non-cancer effects may occur in humans and animals at doses less than 10 times above background exposures (USEPA, 2004; USEPA 2000b). Therefore, as described in detail below, the advisories were developed based on comparison with background exposures.

2.2 Development of Consumption Advisories

Chemical-specific consumption advisories are developed for muscle fillets of commonly caught and consumed fish species for which data were obtained through special surveys, research projects, interagency data sharing, and the Routine Fish Monitoring Program. Advisories for fish of different sizes of the same species may be developed when appropriate (for example, bluefish have no size limits for harvest thus a wide range of sizes may be kept by anglers).

For chemicals that cause developmental effects (mercury, PCBs, dioxin, and PFAS), two levels of advisories are generally issued: one for a high-risk population and one for the general population. High-risk individuals are defined as infants, children, pregnant women, nursing mothers, and women of childbearing age. Advisories based on consumption less frequent than “Monthly” (i.e., "Eat Once Every 3 Months" and “Eat Once Per Year") are not applicable to the high-risk group because consumption at these levels could result in a single high dose during sensitive stages of early life development and should be avoided (USEPA, 2000a).

2.2.1 Site-Specific Consumption Advisories

Fish species from surface waterbodies are targeted by the above-mentioned sampling projects with the emphasis on legal-sized fish that are typically caught and consumed by anglers from the waterbody of interest. Individual waterbodies are sampled regionally (approximately 15-20 sites per region), once every 5 years. The number of fish species collected at each waterbody ranges from one to five depending on species present, field collection success, and budget. At least three fish of each species are collected from each

[2] This is the USEPA (2000a) default recommendation for fish consumption advisories. USEPA has updated the default adult body weight to 80.0 kg (USEPA, 2015), and fish consumption advisory guidance use of this value may be considered for development of consumption triggers in future revisions.

waterbody and analyzed individually. Fish may be analyzed as equal mass composites in cases where there are budget restrictions or additional sample size requirements (e.g., larger bodies of water where more fish may be needed for spatial coverage). Analysis of individual fish is preferred, but in some cases, fish are combined to include data from a larger area within the available analytical budget. All fish are sampled for mercury. PCBs and PFAS are being sampled in many fish, but not all, due to budget constraints and species-specific bioaccumulation potential (described elsewhere), Other contaminants such as pesticides, dioxins (and dioxin-like compounds), PAHs, and metals (other than Hg) are not routinely sampled unless there is a site-specific or species-specific concern, or other environmental data suggesting they be tested. Once analytical data are received from the laboratory, the contaminant concentrations for each species are averaged[3] by waterbody and compared to advisory triggers. Fish with high site fidelity should be targeted for site-specific advisories.

2.2.2 Development of Regional or Statewide Consumption Advisories

Individual species may be examined on a regional or statewide basis by combining data from different locations and calculating the mean contaminant values from across the respective area of interest. Fish from the acidic waters of the Pinelands Region tend to have higher levels of mercury as compared to the same species in non-Pinelands regions of the state. Therefore, fish advisories for mercury have been developed specifically for several species in the New Jersey Pinelands. Statewide advisories have also been developed by comparing mean values for all state waters by species to advisory trigger values. Larger sample sizes may be desired to represent migratory species over a larger geographical area. Larger species known to migrate within coastal waters, particularly those that are seasonally found in estuaries and tidal portions of rivers, are often more appropriate to sample on a larger scale for regional advisories. In these instances, larger sample sizes may be collected to be representative of the population of fish present. Sample size requirements and geographical coverage for advisories may change over time as sampling paradigms shift and budgets allow.

3.0 Consumption Triggers for Specific Contaminants

The basis for consumption triggers for specific contaminants is provided below. The contaminants are listed in the order of their frequency as drivers for New Jersey fish consumption advisories, with contaminants that drive advisories most frequently listed first.

3.1 Mercury

For mercury, the advisory triggers (Table 1) are based upon a RfD of 3×10^{-4} mg/kg-

[3] Averages (arithmetic means) are currently used rather than the geometric mean to be more protective when accounting for small sample sizes. Depending on data distributions, the 95% upper confidence limit may also be considered depending on variability within the data.

day (0.3 µg/kg-day) for adults in the general population and 7 x 10^{-5} mg/kg-day (0.07 µg/kg-day) for infants, children, pregnant women, nursing mothers, and women of childbearing age (the high-risk group). The RfD for the general population is based on paresthesia, a neurological effect that can occur in adults exposed to mercury-contaminated fish. This RfD was initially established by the USEPA and published in the Integrated Risk Information System (IRIS) but has since been updated to 1 x 10^{-4} mg/kg/day to account for developmental exposure (USEPA, 2000c). The TIBC has elected to maintain the previous RfD for general population advisories since developmental endpoints are not relevant in this population. The RfD for the high-risk group was developed by NJDEP, as described in TIBC (1994) with supporting information from Stern (1993). It is based on neurodevelopmental delays in infants and children whose mothers were exposed to mercury through fish consumption. The NJDEP RfD of 7 x 10^{-5} mg/kg/day is close to the current USEPA (2001) IRIS RfD of 1 x 10^{-4} mg/kg/day but is slightly more protective for the same effect.

The TIBC (TIBC, 1994) concluded that the most useful frequency categories for consumption advisories for mercury for both the general population and the high-risk population are unlimited consumption (i.e., daily), one meal per week, one meal per month, and "do not eat" due to concerns regarding a bolus dose. A bolus dose is a single or infrequent high dose that may be problematic because of effects that may occur from short term exposure to a high dose. Therefore, triggers for less frequent consumption (once every 3 months; once per year) are not provided for mercury due to concerns with the bolus exposures at these consumption frequencies (USEPA, 2000a).

Table 1. Mercury fish tissue concentrations (µg/g; mg/kg; ppm) triggering consumption advisories for the general population and high-risk population

Fish Consumption Advisory	General Population (µg/g)	High-Risk Population (µg/g)
No restrictions (based on one 8oz. meal daily)	≤0.093	≤0.019
One meal per week	>0.093 - 0.65	>0.019 - 0.13
One meal per month	>0.65 - 2.81	>0.13 - 0.58
One meal every three months	Not applicable	
One meal per year	Not applicable	
Do not eat	> 2.81	> 0.58

These calculations are based on an RfD of 3 x 10^{-4} mg/kg-day for adults in the general population and 7 x 10^{-5} mg/kg-day for the high-risk population (pregnant and nursing women, women of childbearing age, young children), a meal size of 8 oz. (227 g), a body weight of 70 kg for adults for the general population advisories, and a body weight of 62 kg for women for the high-risk population advisories.

3.2 Polychlorinated Biphenyls (PCBs) [4]

PCBs are classified by USEPA (1996) IRIS as probable human carcinogens and cancer slope factors for PCBs were developed by USEPA, as described below. NJDEP uses the USEPA (1996) cancer slope factor as the basis for its regulatory standards for PCBs (NJDEP, 2008). Since non-cancer effects are also sensitive endpoints for PCBs, both cancer risk and non-cancer effects were evaluated for development of consumption triggers.

3.2.1 Triggers based on cancer risk

A variety of commercial mixtures (Aroclors) of PCB congeners with various degrees of chlorination are carcinogenic in rodents. Epidemiological studies also suggest that an elevated PCB body burden is associated with an increased human cancer incidence (USEPA, 1996). USEPA (1996) IRIS recommends three slope factors for PCBs, based on a range of cancer potency factors from a chronic rat study of several Aroclors (Aroclor 1260, Aroclor 1254, Aroclor 1242, Aroclor 1016). The recommended slope factors are based on the environmental medium in which the PCBs are found. This approach is based on information indicating that "environmental processes alter (Aroclor) mixtures through partitioning, transformation, and bioaccumulation, thereby decreasing or increasing toxicity" (USEPA, 1996). Specifically, congeners that evaporate or are dissolved in water are the least toxic and persistent, while congeners adsorbed to sediment or soil are more toxic and persistent, and congeners that bioaccumulate through the food chain, including in fish, are the most toxic and persistent of all (USEPA, 1996). Of the Aroclors tested, Aroclor 1254 had the highest cancer slope factor, 2.0 $(mg/kg/day)^{-1}$. This slope factor was recommended by USEPA (1996) for PCBs found in the food chain (e.g., fish), as well as for early life exposure, regardless of the pathway or type of PCB mixture.

The history of New Jersey fish consumption advisories for PCBs and dioxins is presented in Appendix A. Fish consumption advisories for PCBs that were adopted by New Jersey in 2002 and issued in 2003 were based on a range of cancer risks from 10^{-5} to 10^{-4}. The 10^{-4} risk level was adopted for PCB fish consumption advisories in 2006 to better balance the risks versus benefits of consuming fish. Triggers based on a cancer slope fact of 2.0 $(mg/kg/day)^{-1}$ and the 10^{-4} cancer risk level are shown in Table 2.

3.2.2 Alternative approach for PCB carcinogenic risk calculations utilizing dioxin Toxic Equivalence Factors (TEFs)

The USEPA (1996) slope factors for PCBs apply to mixtures of PCBs since data to

[4]A draft of the triggers for PCBs was reviewed by Dr. Vincent Cogliano, formerly of the USEPA National Center for Environmental Assessment and primary USEPA expert on PCB toxicology, and Dr. Michael Gallo of the University of Medicine and Dentistry of New Jersey (dissolved in 2013, now Rutgers School of Biomedical and Health Sciences) who agreed that the approaches described were technically sound and consistent with USEPA's recommended risk-based approach at the time.

develop slope factors for individual congeners are not available. However, as discussed in USEPA (1996), if congener-specific analysis is conducted, the risk assessment can be based on separation of the congeners into dioxin-like PCBs and non-dioxin-like PCBs. Toxic Equivalence Factors (TEFs), discussed in the section on *Dioxins and Dioxin-like Compounds* below, can be utilized to convert the concentrations of dioxin-like PCBs to equivalent concentrations of 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD). The 2,3,7,8-TCDD slope factor, rather than the PCB slope factor, can then be used to assess the risk of that portion of the PCB exposure resulting from dioxin-like PCBs. If levels of dioxin congeners in the fish are also known, the total risk from dioxins and dioxin-like PCBs can be calculated. This is a different approach than the was used for NJ fish consumption triggers for PCBs based on cancer risks that are discussed above.

3.2.3 Triggers based on non-cancer effects

The most sensitive non-cancer effects of PCBs relate to reproductive and developmental endpoints. The literature on these effects was extensively reviewed and evaluated by Dr. Perry Cohn of NJDOH (formerly Department of Health and Human Services) (Cohn, 2000). In studies of human infants exposed to PCBs through breast milk, a range of NOAELs of 2.5 - 8 x 10^{-5} mg/kg/day for maternal exposure were reported. These NOAELs are based on observations in human populations, without incorporation of an uncertainty factor to account for potentially more sensitive individuals within the population, as would be done if an RfD for this effect were to be developed. Since a NOAEL rather than an RfD, which includes uncertainty factors, was used as the basis for trigger values, it was prudent to utilize the lower end of the range, 2.5 x 10^{-5} mg/kg/day.

The PCB tissue concentration advisory triggers in Table 2 were developed in 2002. As shown in Table 2, the trigger values for non-cancer developmental effects are lower (more stringent) than the values based on 10^{-4} cancer risk. Therefore, the non-cancer triggers are used as the basis for advisories for the high-risk population. As discussed above, advisories based on consumption less frequent than “Monthly” (i.e., "Eat Once Every 3 Months" and “Eat Once Per Year") are not applicable to the high-risk group because consumption at these levels could result in a single high dose during potentially sensitive stages of early life development.

Table 2. PCB tissue concentrations (µg/kg; ppb) triggering consumption advisories based on cancer risk for the general population and non-cancer effects for the high-risk population

Fish Consumption Advisory	General Population (µg/kg ; 1 x 10^{-4} Cancer Risk)	High-Risk Population (µg/kg ; Non-Cancer Risk)
No restrictions (based on one 8oz. meal daily)	≤15	≤8
One meal per week	>15-110	8-56
One meal per month	>110-470	56-240
One meal every three months	>470-1400	Not applicable
One meal per year	>1400-5600	Not applicable
Do not eat	>5600	>240

Calculations are based on a cancer slope factor of 2 $(mg/kg/day)^{-1}$ for cancer risk in the general population (1 x 10^{-4} cancer risk), a reference dose of 2.5 x 10^{-5} mg/kg/day for non-cancer risk, a meal size of 8 oz. (227 g), and a body weight of 70 kg.

3.3 Dioxins and Dioxin-like Compounds

The history of New Jersey fish consumption advisories for PCBs and dioxins is presented in Appendix A. For dioxin, New Jersey formerly used an FDA regulatory opinion issued in 1983 that is based upon the following tissue concentrations of 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD), the most well-studied of the dioxin compounds (Table 3).

Table 3. Historic 2,3,7,8-TCDD tissue concentrations (pg/g or parts per trillion, ppt) used as the basis of FDA regulatory opinion on dioxin (1983) for consumption advisories

Fish Consumption Advisory	Dioxin Concentration (pg/g)
No restrictions (based on one 8oz. meal daily)	≤25
Monthly	25-50
Do not eat	50

In 2004, the Risk Subcommittee recommended revised triggers based on a toxic equivalence (TEQ) approach based on total TEFs for dioxins and dioxin-like compounds, as described below. These revised triggers were adopted as of the 2006 Fish Consumption Advisories (Table 4).

3.3.1 TEQ Approach

2,3,7,8-TCDD occurs in the environment along with other chemically and toxicologically related compounds including the other chlorinated dibenzodioxins,

chlorinated dibenzofurans, and dioxin-like PCBs which are, as a group, called dioxin-like compounds. There are 17 toxic dioxins and furan congeners and 11 dioxin-like PCBs. All of these chemicals produce similar biological effects with varying potencies and act together in an additive fashion. Each of the dioxin-like compounds has been assigned a TEF, which relates its toxic potency to that of 2,3,7,8-TCDD (Van den Berg et al., 1998; Van den Berg et al., 2006). The toxicity of a mixture of dioxin-like compounds is expressed in terms of 2,3,7,8-TCDD TEQ determined by multiplying the concentration of each dioxin-like compound by its TEF and summing these values for all dioxin-like compounds present. Because the dioxin-like chemicals all produce similar toxic effects, the TEQ approach should be used when evaluating the risks of consuming fish containing a mixture of these contaminants.

A risk-based approach for dioxin and related compounds was not considered feasible since the lifetime cancer risk resulting from background exposures to dioxin-like compounds was estimated to be about one in one thousand or 1×10^{-3}, and non-cancer effects may occur at doses less than 10 times above background (USEPA, 2000b). Therefore, the advisories were developed based on comparison with background exposures.

For the general population, it is recommended that the fish consumption advisory be based on an intake of dioxin and related compounds equal to the daily background exposure from the total diet which was reported to be 65 pg/day, or approximately 1 pg/kg/day (USEPA, 2000b). Thus, consumption of fish resulting in this level of exposure would result in a doubling of the background risk. Using an assumption that a fish meal is 8 ounces or 227 grams, this results in a TEQ concentration of 0.29 pg/g (ppt) for an advisory based on daily exposure. Since dioxin has a long human half-life of approximately seven years and is not acutely toxic at the levels relevant to weekly or monthly fish advisories, recommendations for advisories based on weekly and monthly exposure for fish with higher dioxin levels are also given in the table below. Advisories for consumption less frequent than one meal per three months (e.g., yearly) are not given because consumption of one meal of fish at the calculated yearly advisory level would result in a dose that exceeds the ATSDR Minimum Risk Level for non-cancer effects from acute oral exposure to dioxin (ATSDR, 1998) of 2×10^{-4} µg/kg/day (200 pg/kg/day; equivalent to a fish tissue concentration of 61 pg/g [ppt]).

For the high-risk population, including pregnant and nursing mothers, women of childbearing age, and young children, consumption of fish is beneficial as part of a healthy diet. For this population, it is recommended that daily dioxin exposure from consumption of fish should not exceed twice the exposure of an average meal in the U.S. general population. The dioxin exposure from an average meal was estimated as one-third of the average background dietary exposure of 65 pg/day (0.065 ng/day), or 0.022 ng. A fish meal resulting in twice the exposure of an average meal would contain 0.044 ng/0.227 kg fish or 0.19 ng/kg (ppt). This exposure is likely to fall within the range of normal dietary variation. Using this approach, consumption should not exceed one meal per day of fish containing up to 0.19 ppt TEQ. Advisories allowing less frequent than monthly exposures for fish with higher

contaminant levels are not recommended for the sensitive population to avoid large bolus doses at what may be critical developmental time points.

Table 4. Dioxin TEQ fish tissue concentrations (pg/g; ppt) triggering consumption advisories for general and high-risk populations

Fish Consumption Advisory	General Population (pg/g)	High Risk Population (pg/g)
No restrictions (based on one 8oz. meal daily)	≤0.28	≤0.19
One meal per week	>0.28 - 2.0	>0.19 - 1.3
One meal per month	>2.0 - 8.6	>1.3 - 7.7
One meal every three months	>8.6 - 26	Not applicable
One meal per year	Not applicable	Not applicable
Do not eat	>26	>7.7

Based on a meal size of 8 oz. (227 g), a body weight of 70 kg for adults for the general population advisories, and a body weight of 62 kg for women in the high-risk population advisories.

3.4 PFAS

In 2018, fish advisory triggers were developed for perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA), and perfluorooctanoic acid (PFOA) (Post et al., 2018). PFUnDA triggers were developed in 2022 (Toxics in Biota Risk Subcommittee, 2022). These are four PFAS found in New Jersey fish for which toxicity factors are available (other PFAS have toxicity factors but may not bioaccumulate in fish to levels of concern). These triggers were based on the standard exposure assumptions used for other New Jersey fish consumption advisories of a 227-gram (8 ounce) meal size and 70 kg body weight. Trigger levels were developed for the following consumption frequencies: unlimited consumption, consumption once per week, once per month, once every 3 months, once per year, and do not eat.

PFOS, PFNA, and PFOA cause developmental toxicity in laboratory animals and are associated with decreased birth weight in humans. Therefore, the fetus and infant/young child are considered susceptible subpopulations for the developmental effects of these PFAS (DWQI, 2015; DWQI, 2017; DWQI, 2018; USEPA, 2016a; USEPA, 2016b; USEPA, 2021a, USEPA, 2021b). Because long-chain PFAS such as PFOS, PFNA, and PFOA have long human half-lives (several years), body burdens remain elevated for many years after exposure ends. Therefore, if women have elevated body burdens when they become pregnant, these body burdens will remain elevated during pregnancy and lactation. PFOS, PFNA, and PFOA are present in human breast milk, and serum PFAS levels in breast-fed infants are typically higher than maternal serum levels. For these reasons, it is not advisable for subgroups of concern for developmental effects (pregnant women, young children, women of childbearing

age) to receive large doses of PFOS, PFNA, PFOA, or PFUnDA, even if infrequent. Therefore, the advisory triggers for consumption "Once Every 3 Months" or "Yearly" are not considered to be protective for individuals in these high-risk groups. For the general population (i.e., all others not in the high-risk group) these meal frequencies are recommended (Table 5). As discussed above, this approach was also used for fish consumption advisories for other contaminants that cause developmental toxicity, such as mercury and PCBs.

For the PFOS fish consumption advisory triggers, the RfD developed by the NJ Drinking Water Quality Institute (DWQI), with support from the NJDEP Division of Science & Research of 1.8 ng/kg/day (DWQI, 2018) is used as the toxicity basis. This RfD is based on decreased immune response, as indicated by decreased plaque forming cell response, in mice (Dong et al., 2009). The DWQI also evaluated cancer risk from exposure to PFOA and concluded that the RFD for non-cancer effects is also expected to be protective of cancer risk at close to the one-in-one-million (10^{-6}) risk level.

For PFNA, the RfD of 0.74 ng/kg/day from the NJDEP Ground Water Quality Standard for PFNA (NJDEP, 2017a) is used as the toxicity basis. This RfD is based on increased liver weight in pregnant mice (Das et al., 2015), and it includes an uncertainty factor for potentially more sensitive effects, including developmental effects. PFNA has not been evaluated for carcinogenic effects.

For PFOA, the RfD developed by the NJ DWQI of 2.0 ng/kg/day (DWQI, 2017) is used as the toxicity basis. This RfD is based on increased liver weight in mice (Loveless et al., 2006), and it includes an uncertainty factor for potentially more sensitive low-dose developmental effects. It is also expected to be protective of cancer risk at the one-in-one-million (10^{-6}) risk level.

For PFUnDA, the RfD of 1.3 ng/kg/day was developed by the Risk Subcommittee (Toxics in Biota Risk Subcommittee, 2022) and approved by the TIBC. Like other PFAS, PFUnDA causes hepatic and developmental toxicity in laboratory animals. The critical endpoint selected as the basis for the Reference Dose (RfD) was increased relative liver weight in male rats (Takahashi et al., 2014).

It should be noted that available information indicates that some of the target organs and modes of action are similar for PFAS in general, including PFOS, PFNA, PFOA, and other PFAS detected in New Jersey fish. Therefore, the toxicity of these PFAS may be additive. However, the potential for additive toxicity of PFAS was not considered in development of these fish consumption advisory triggers. Consumption advisory triggers based on the RfDs for PFOS, PFNA, PFOA, and PFUnDA are shown in Table 5.

Additionally, it should be noted that USEPA (2024a,b) has recently finalized Reference Doses and cancer slope factors for PFOA and PFOS that are more stringent than the NJ DWQI toxicity factors used to develop fish consumption triggers above. These more recent toxicity factors will be considered in future reevaluations of the fish consumption

triggers for PFOA and PFOS.

Table 5. PFAS fish tissue concentrations triggering consumption advisories for the general population and high-risk population (ng/g; µg/kg; ppb).

	General Population (ng/g)				High-Risk Population (ng/g)			
Advisory Level:	**PFOA**	**PFNA**	**PFOS**	**PFUnDA**	**PFOA**	**PFNA**	**PFOS**	**PFUnDA**
No restrictions (based on one 8oz. meal daily)	≤0.62	≤0.23	≤0.56	≤0.4	≤0.62	≤0.23	≤0.56	≤0.4
One meal per week	>0.62-4.3	>0.23-1.6	>0.56-3.9	>0.4-2.8	>0.62-4.3	>0.23-1.6	>0.56-3.9	>0.4-2.8
One meal per month	>4.3-19	>1.6-6.9	>3.9-17	>2.8-12	>4.3-19	>1.6-6.9	>3.9-17	>2.8-12
One meal every 3 months	>19-57	>6.9-21	>17-51	>12-37	Not applicable	Not applicable	Not applicable	Not applicable
One meal every year	>57-226	>21-84	>51-204	>37-146	Not applicable	Not applicable	Not applicable	Not applicable
Do Not Eat	>226	>84	>204	>146	>19	>6.9	>17	>12

Triggers for PFOS and PFOA are based on DWQI RfDs; PFNA and PFuNDA triggers are based on NJDEP developed RfDs. Trigger calculations are based on a meal size of 8 oz. (227 g), and a body weight of 70 kg.

3.5 Chlordane

Chlordane is classified as a probable human carcinogen by both USEPA (1998) IRIS and NJDEP (DWQI, 1987). The current triggers for chlordane were developed in 2004 and are based on the NJDEP cancer slope factor of 2.7 $(mg/kg/day)^{-1}$ (DWQI, 1987) and a 10^{-4} lifetime cancer risk. Since the triggers are not based on effects specific to the high-risk population (pregnant and nursing women, young children, women of childbearing age), these triggers apply to both the general population and the high-risk population (Table 6).

Table 6. Chlordane tissue concentrations (ng/g; ppb) triggering consumption advisories based on 1 x 10^{-4} cancer risk

Advisory Level	Chlordane Concentration (ng/g)
No restrictions (based on one 8oz. meal daily)	≤11
One meal per week	>11 – 80
One meal per month	>80 – 340
One meal every three months	>340 - 1,000
One meal per year	>1,000 - 4,200
Do not eat	>4,200

These calculations are based on a NJDEP cancer slope factor of 2.7$(mg/kg/day)^{-1}$, a meal size of 8 oz. (227 grams), and a body weight of 70 kg.

For total chlordane, New Jersey initially used FDA action levels, previously issuing advisories based upon the following tissue concentrations:

> 300 µg/kg (ppb) - Do not eat.

< 300 µg/kg (ppb) - Unlimited consumption.

3.6 DDT & Metabolites

DDT, DDD, and DDE are classified as probable human carcinogens (Group B2) by USEPA IRIS (USEPA, 1988a,b,c). The current consumption triggers for DDT, DDD, and DDE are based on USEPA (2000a) guidance for developing fish consumption limits for these contaminants. USEPA (2000a) recommends that a cancer slope factor of 0.34 $(mg/kg/day)^{-1}$ be used for the combined concentration of DDT, DDD, and DDE. This cancer slope factor and a cancer risk level of 10^{-4} were used to develop the trigger levels based on cancer risk shown in Table 7. The USEPA IRIS RfD for DDT, which was developed in 1987 and was also recommended by USEPA (2000a), was used to develop the trigger levels for non-cancer effects. This RfD is based on liver toxicity and is not specific to the high-risk population (pregnant and nursing women, women of childbearing age, young children). Since the 10^{-4} lifetime cancer risk advisory triggers are more stringent than the non-cancer risk values, the former values are used for all consumers (general population and high-risk population).

Table 7. DDT & metabolite tissue concentration (µg/kg; ppb) triggering consumption advisories based on cancer risk and non-cancer endpoints.

Consumption Frequency	1 x10^{-4} Risk (µg/kg)	Non-Cancer Risk (µg/kg)
No restrictions (based on one 8oz. meal daily)	≤86	≤150
One meal per week	>86 – 690	>150 – 1200
One meal per month	>690 – 2,800	>1,200 – 4,700
One meal every three months	>2,800 – 8,400	>4,700 – 14,000
One meal per year	>8,400 - 33,000	14,000 > 56,000
Do not eat	> 33,000	> 56,000

These calculations are based on a cancer slope factor of 0.34 (mg/kg/day)$^{-1}$, an RfD of 5 x 10^{-4} mg/kg/d, a meal size of 8 oz. (227 grams) and a body weight of 70 kg.

New Jersey formerly used FDA Action Levels in setting fish consumption advisories for DDT and its metabolites (e.g., DDD, DDE). Previous advisories were based on the following fish tissue concentrations:

> 5,000 µg/kg (ppb) - Do not eat
< 5,000 µg/kg (ppb) - Unlimited consumption

3.7 Lead

Fish advisory trigger levels for lead were developed in August 2012. Lead causes neurodevelopmental effects in children. Unlike other contaminants that cause non-cancer effects, no RfD has been developed for lead because no threshold has been identified for its neurodevelopmental effects. In May 2012, the Centers for Disease Control (CDC) revised its guidance on childhood lead exposure to define its blood lead reference value as 5 µg/dL. This blood lead reference value (BLRV) was based on the 97.5th percentile of the blood lead concentration of the US population of children 1-5 years old from 2007-2010 National Health and Nutrition Examination Survey (NHANES) data. Children with blood lead levels at or above the BLRV were within the highest 2.5% of blood lead levels (CDC, 2021). It is noted that the CDC revised its BLRV to 3.5 µg/dL in 2021, based on the 97.5th percentile of more recent NHANES data from 2015-18. Additionally, it should be noted that CDCs BLVRs are not intended to represent estimates of a threshold for adverse effect, but rather, guidance for a practical response level.

Fish consumption triggers were developed based on the concentration of lead in fish tissue at which a maximum of 5% of children are theoretically predicted to exceed a blood lead concentration of 5 µg/dL, representing a theoretical doubling of the percentage of children with blood lead concentrations >5 µg/dL. A child's fish meal size of 4 oz (113 g) was assumed. It was concluded that this approach appropriately balances the benefits of fish

consumption with the risks of consuming lead in fish.

The USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model for lead in children (Model Version 1.1, Build 11; updated in 2021 to Version 2; see https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals) predicts the blood lead concentration distribution for the population of children 0-7 years old with a given set of lead intakes from diet, air, water, and soil/dust. The IEUBK model was used to predict that, for daily consumption of 113 g of fish, a lead fish tissue concentration of 0.034 µg/g will result in 5% of the population less than 6 years old having a blood lead concentration exceeding 5 µg/dL (i.e., 95% of the population < 5 µg/dL). For blood lead concentrations <10 µg/dL, the kinetics of lead absorption, distribution, and elimination are linear with respect to intake rate, and the predictions of the IEUBK model reflect this linearity (Maddaloni, 2012). Therefore, the fish lead concentration corresponding to once per week and once per month consumption were derived directly from the concentration calculated for daily consumption by multiplying the acceptable daily concentration by 7 days/week and 30.4 days/month respectively. Because lead causes neurodevelopmental toxicity in children, fish consumption advisories for consumption less frequent than once per month (e.g., once every three months, once per year) that would result in larger bolus doses of lead were not considered to be health protective and were not recommended.

The fish lead concentration corresponding to each consumption frequency category based on the IEUBK model predictions for daily fish consumption are shown in Table 8.

Table 8. Lead concentration (µg/g; mg/kg; ppm) in fish tissue predicted to result in 95% of the population <6 years old with blood lead less than 5 µg/dL for each fish consumption advisory category (5% >5 µg/dL).

Consumption Frequency	Lead Concentration (µg/g) to Achieve 5% >5 µg/dL
No restrictions (based on one 8oz. meal daily)	≤0.034
One meal per week	>0.034-0.24
One meal per month	>0.24-1.03
Do Not Eat	>1.03

The assumed portion size of 113 g and the fish Pb concentration of 0.034 µg/g for daily consumption corresponds to a daily Pb intake from fish of 3.8 µg.

3.8 Polycyclic Aromatic Hydrocarbons (PAHs)

NJDEP PAH advisory triggers were developed in 2010 and are based on the approaches and trigger values provided in USEPA (2000a) and a cancer risk level of 10^{-4} (Table 9). Fish consumption advisories for PAHs are determined using potency equivalency concentrations (PECs), which can be calculated using the USEPA TEFs from 1993 and methods described in USEPA 2000a, Section 5.3.2.5. USEPA (2000a) recommends that TEFs (Nisbet and Lagoy, 1992; USEPA, 1993) with benzo(a)pyrene, the index compound assigned

a value of 1, be used to calculate a PEC for 15 PAHs (including benzo(a)pyrene [BaP] and 14 other PAHs). Fish tissue samples should be analyzed for these 15 PAHs and the order-of-magnitude relative potencies given for these PAHs (Nisbet and LaGoy, 1992; USEPA, 1993) be used to calculate PECs for each sample to be summarized and compared to the NJDEP trigger values.

Table 9. PAH tissue concentrations (µg/kg; ppb) triggering consumption advisories for the general population and high-risk population

Fish Consumption Advisory	General Population (µg/kg)	High-Risk Population (µg/kg)
No restrictions (based on one 8oz. meal daily)	≤4	≤4
One meal per week	>4 - 32	>4 - 32
One meal per month	>32 - 130	>32 - 130
Six meals/year	>130 - 260	>130 - 260
Do not eat	>260	>260

These calculations are based on a cancer slope factor of 7.3 $(mg/kg/day)^{-1}$, a 10^{-4} Lifetime Cancer Risk Level, a meal size of 8 oz. (227 grams), and a body weight of 70 kg.

In 2010, USEPA proposed an update of this approach based on Relative Potency Factors (RPFs) for benzo(a)pyrene and 24 other PAHs, but these RPFs were not finalized, and USEPA has suspended work on this project as of USEPA fiscal year 2019 (Table 10; USEPA, 2010). This assessment may be restarted as Agency priorities change. For more information, see the USEPA notice at:

https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NCEA&dirEntryId=194584

Table 10. Comparison of USEPA (1993) Toxicity Equivalency Factors (TEFs) and Draft USEPA (2010) Polycyclic Aromatic Hydrocarbon (PAH) Relative Potency Factors (RPFs)

		DRAFT USEPA (2010)		
PAH	**EPA TEF (1993)**	**Average RPF**	**Range of RPFs**	**Relative confidence**
Acenaphthene	0.001	Excluded due to inadequate data		
Acenaphthylene	0.001	Excluded due to inadequate data		
Anthanthrene	---	0.4	0.2–0.5	Medium
Anthracene	0.01	0	0	Medium
Benz[a]anthracene	0.1	0.2	0.02–0.4	Medium
Benz[b,c]aceanthrylene, 11H-	----	0.05	0.05	Low
Benzo[b]fluoranthene	0.1	0.8	0.1–2	High
Benzo[c]fluorene	----	20	1–50	Medium
Benz[e]aceanthrylene	----	0.8	0.6–0.9	Low
Benzo[g,h,i]perylene	0.01	0.009	0.009	Low
Benz[j]aceanthrylene	----	60	60	Low
Benzo[j]fluoranthene	----	0.3	0.01–1	High
Benzo[k]fluoranthene	0.1	0.03	0.03–0.03	Medium
Benz[l]aceanthrylene	----	5	4–7	Low
Benzo(a)pyrene (reference compound)	1	1	Not applicable	Not applicable
Chrysene	0.01	0.1	0.04–0.2	High
Cyclopenta[c,d]pyrene	----	0.4	0.07–1	Medium
Cyclopenta[d,e,f]chrysene, 4H-	----	0.3	0.2–0.5	Low
Dibenzo[a,e]fluoranthene	----	0.9	0.7–1	Low
Dibenzo[a,e]pyrene	----	0.4	0.3–0.4	Low
Dibenz[a,h]anthracene	5	10	1–40	High
Dibenzo[a,h]pyrene	----	0.9	0.9	Low
Dibenzo[a,i]pyrene	----	0.6	0.5–0.7	Low
Dibenzo[a,l]pyrene	----	30	10–40	Medium
Fluoranthene	0.001	0.08	0.009–0.2	Low
Fluorene	0.001	Excluded due to inadequate data		
Indeno[1,2,3-c,d]pyrene	0.1	0.07	0.07	Low
Naphtho[2,3-e]pyrene	----	0.3	0.3	Low
Phenanthrene	0.001	0	0	High
Pyrene	0.001	0	0	Medium

3.9 Cyanotoxins

Fish consumption advisory triggers for microcystin-LR, cylindrospermopsin, and anatoxin-a, the three cyanotoxins for which NJDEP toxicity factors are available, were developed in 2020 (Post et al., 2020) (Table 11). The fish consumption triggers for cyanotoxins are based on short-term exposures because the harmful algal blooms that produce these toxins persist for up to several months, and chronic consumption of fish

contaminated with cyanotoxins is therefore not expected. The triggers are based on RfDs intended to be protective for short-term exposures to cyanotoxins and use the same exposure assumptions used for other New Jersey fish consumption advisory triggers for other contaminants (227 gram [8 ounce] meal size and 70 kg body weight). Since the RfDs for cyanotoxins are not based on effects specific to the high-risk population (pregnant and nursing women, young children, women of childbearing age), the same triggers apply to both the general population and the high-risk population.

The NJDEP short-term RfDs for microcystin, cylindrospermopsin, and anatoxin-a were developed in 2017 (NJDEP, 2017b). A review of more recent literature concluded that no updates were needed (NJDEP, 2020).

The NJDEP short-term RfD for microcystin-LR is 0.01 µg/kg/day. It is applied to the total concentration of microcystin congeners that are measured. The RfD is based on decreased weight gain and changes indicative of liver toxicity in mice dosed with microcystin-LR for 91 days (Fawell et al., 1994; 1999).

The NJDEP short-term Reference Dose (NJDEP, 2017b) for cylindrospermopsin is 0.03 µg/kg/day. It is based on increased relative kidney weight in mice exposed to cylindrospermopsin (Humpage and Falconer, 2003).

The NJDEP short-term Reference Dose (NJDEP, 2017b) for anatoxin-a is 0.1 µg/kg/day. It is based on lethality in mice exposed for 28 days (Fawell and James, 1994; Fawell et al., 1999). These RfDs were used to develop the trigger levels shown.

Table 11. Cyanotoxin fish tissue concentrations (µg/kg; ppb) triggering consumption advisories

Fish Consumption Advisory	**Microcystin-LR (µg/kg)**	**Cylindrospermopsin (µg/kg)**	**Anatoxin-a (µg/kg)**
No restrictions (based on one 8oz. meal daily)	≤ 3.1	≤ 9.3	≤ 31
One meal per week	> 3.1- 22	> 9.3 - 65	>31 - 220
One meal per month	> 22 - 93	> 65 - 280	> 220 - 930
One meal every three months	Not applicable		
One meal per year	Not applicable		
Do not eat	>93	>280	>930

These calculations are based on a meal size of 8 oz. (227 g), and a body weight of 70 kg.

4.0 Procedures for Fish Advisories in Shared Waters

Neighboring states (New York, Pennsylvania, and Delaware) share waters with NJ, and each State has its own methods, procedures, and assumptions for developing advisories. Additionally, the Delaware River Basin Commission independently samples fish from sites along of the Delaware River for contaminants and shares this data between the relevant agencies. Generally, NJ uses individual contaminants (e.g., PCB and dioxin risk separately) to set fish advisories and several default values when calculating triggers that may differ from other States. NJ currently uses a 10^{-4} cancer risk for carcinogens, a 70-year life expectancy and a 70-year exposure period. NJ also assumes a 70 kg body weight, and 62 kg for body weight when reproductive endpoints are linked to the reference dose. These assumptions, along with contaminant specific reference doses, provide the basis for NJ fish consumption advisories. Discussions and comparisons of methods between agencies for shared waters are ongoing as of the completion of this document.

5.0 Procedures for Revising Fish Consumption Advisories

Since 1983, the TIBC has evaluated toxic contamination of fish and biota, recommended fish consumption advisories, and assisted in the development and dissemination of information to the public concerning these advisories. One of the goals of the TIBC is to evaluate the appropriateness of current fish consumption advisories and the need for modifications based on new monitoring, toxicology, or risk assessment data. Prior advisories were based on various episodic monitoring and toxicological studies conducted by state and federal agencies. These advisories were derived using a comparison of mean concentrations of contaminants in fish tissues (typically fillets) to a guidance value, or a comparison of the percentage of samples that exceed a guidance value; usually FDA action or tolerance limits. After approximately 25 years of non-routine monitoring, a routine monitoring program was established and initiated in 2002. The Routine Monitoring Program for Toxics in Fish (Routine Monitoring Program) is designed to sample the state's waters on a rotating five-year cycle.

In 1994, a risk-based method was used to set mercury advisories, and, in 2003, the advisory basis for polychlorinated biphenyls (PCBs) was revised. These advisories are based on a tiered system in which categories of meal frequencies were recommended based on tissue concentrations, rather than the prior method of providing advisory based on a single 'not to exceed' concentration (e.g., FDA tolerance limit for PCBs). Additional advisory triggers for other contaminants have been added since, as described earlier in this document.

Historically, advisories have been based on the most recent monitoring data available for a particular waterbody or species and did not consider trends due to the lack of long-term comprehensive data. With the initiation of the Routing Monitoring Program, multiple data points are now (and will be) available to assess potential trends and for developing fish consumption advisories. However, a procedure needs to be established in order to properly and consistently assess the data. Several factors can make data comparison difficult, even

when using the same species from the same water body. Contaminant concentrations tend to be higher in larger and older fish, as well as fish higher on the food chain (i.e., predators)[5]. Therefore, observed changes in contaminant concentrations over time can be related to fish size, fish age, as well as changes in contaminant exposure (e.g., decrease/increase in water or sediment contaminant concentrations). Data variability should also be considered because of the relatively low numbers of samples collected. It is important to take these types of factors into consideration when comparing data, examining trends, and recommending fish advisories.

The following procedure outlines the general method to follow when: 1) revising a human health fish consumption advisory or 2) removing an advisory. Due to the varied and numerous situations that could arise with the data, this procedure sets basic methods to follow to minimize the negative effects of the variables mentioned previously upon data interpretation. Flexibility and professional judgment are important aspects of this procedure due to the impracticality of preparing methods for all potential situations.

5.1 Revising Fish Consumption Advisories

Advisories are regularly updated (no change in advisory) or revised (advisory changes) using the newest set of available data (routine sites are sampled every 5 years). If, for some reason, data are not reasonably supported (e.g., if there is an indication of an analytical inconsistency or error, or if there is reason to believe that the samples in the most recent round of sampling are not representative), it is recommended to use the average of the past two sampling rounds when considering a revision to the fish advisory. Following adjustments in contaminant concentration based on specimen size and/or age, and after consideration of the possible trend, waterbody geo-chemical conditions, and potential contaminant sources, a decision can be made on whether an advisory revision is warranted.

Given the potential annual variability of contaminants in tissue, one-time large increases or decreases in contaminant concentrations may be observed. In the case of the evaluation resulting in a change in the advisory of two or more categories (e.g., from “do not eat” to “one meal per week”), a comparison of the data’s confidence intervals along with professional judgment will be used to decide if the change is appropriate.

Step 1. Assess Species Chemical Contaminant Data:

- Review all relevant chemical contaminant data[6] available for each species on a statewide, region-wide, and water body specific basis.

[5] Normally, only fish that exceed the regulatory minimum size are collected (i.e., fish that can be kept and consumed by recreational anglers).

[6] Use the contaminant(s) that results in the most restrictive consumption advisories when recommending advisories.

- Where possible, establish an arithmetic average contaminant concentration for each species on a statewide, region-wide, and water body specific basis.
- Review all recent contaminant data (past 1-5 yrs.) for each species on a statewide, region-wide, and water body specific basis.

Step 2. Establish Trend Analysis:

- Where possible, evaluate possible trends in contaminant concentrations (i.e., a description of the changes in concentration over time, including statistical and graphical evaluations) for each species on a statewide, region-wide, and water body specific basis.

Step 3. Review Ancillary Data:

- Where possible, review size and/or age data for each species for a specific water body.
  - Where data support appropriate statistical analysis, review size and age data in relation to contaminant levels (i.e., establish length-age database for each species).
- Where possible, utilize all ancillary data available for each water body to provide some insight/explanation for the trends identified (e.g., point sources, presence of hazardous waste site, completion of hazardous waste cleanup, or high lipid species, etc).

Step 4. Determine Revision of Fish Advisories:

- Using the analysis conducted in steps 1 through 3 determine whether the new data under review is representative. Potential factors to consider:
  - Do new data follow previously observed trends over several sampling periods?
  - Is there a significant/substantial change in the average concentration of the new data since the prior sample?
  - Is there a plausible explanation for one-time large increases or decreases in contaminant concentration in the new data?

5.2 Removing a Fish Advisory

The following procedure should be adhered to in order to determine if an advisory should be removed that would result in "unlimited" consumption.[7] An advisory of "no consumption" (i.e., do not eat) or very limited consumption (i.e., four meals per year or one meal per year) shall not be removed unless at least two consecutive sampling events with

[7] Foran (1992) recommended the State of New Jersey adopt Missouri's method for removing or reducing an advisory. These recommendations are summarized in this section.

samples of statistically adequate quantity and quality indicate that average concentrations have dropped below the unlimited consumption advisory trigger. In cases with less stringent advisories (i.e., one meal per week or one meal per month), at least one sample event with samples of adequate size supported as appropriate by other information (e.g., information on changes in the use of a toxicant, emissions rates, atmospheric data, changes in other water bodies) must indicate that average concentrations have dropped below the unlimited consumption advisory trigger. These changes should be written up and clearly identified in the annual advisory updates within the TIBC committee and memorandums to inform management (NJDEP, NJDOH, NJDA) of advisory updates. In addition, this decrease in average concentration should agree with an observed trend of decreasing concentrations over multiple years (even if only the most recent data indicate an "unlimited" advisory).

6.0 Public Communication

Communicating fish consumption advisories to the public is a crucial step for conveying the potential risks of consuming locally caught fish and safeguarding public health. NJ's advisories provide vital information about potential contaminants, such as mercury and PCBs, which can pose serious health risks, especially to vulnerable populations like pregnant women and children. Effectively disseminating this information empowers individuals to make informed decisions about their dietary choices, balancing the nutritional benefits of fish with safety considerations. Additionally, clear communication fosters trust and transparency, encouraging community engagement in environmental and health initiatives.

Currently, fish consumption advisories are posted in multiple formats on the NJDEP's Fish Smart Eat Smart page (https://dep.nj.gov/dsr/fish-advisories-studies/). There is an interactive map where the user can click on a waterbody to view specific advisories. "Booklets" are available and include the most recent updates for all sites in the state. Summary brochures are currently available in English, Spanish, Portuguese, Tagalog, Korean, Chinese, and Polish. In addition, updated advisories are sent by NJDOH to local health departments, staff give presentations to interested state and local groups, and brochures are printed for NJDEP staff to hand out at tabling events such as fishing derbies or municipal community days. Program leads actively respond to inquiries from the public through email or phone calls to help individuals make decisions on where to fish, and data requests for specific sites are honored as data become publicly available. Within NJDEP, as of the publication of this report (2024), program leads are partnering with the NJDEP Office of Environmental Justice to update brochures, revise the Fish Smart Eat Smart outreach plan, and determine next steps to continue to provide the public with up-to-date information effectively.

7.0 References

Agency for Toxic Substances and Disease Registry. (1998). Toxicological Profile for Chlorinated Dibenzo-p-dioxins. U.S. Department of Health and Human Services. December 1998. https://www.atsdr.cdc.gov/toxprofiles/tp104.pdf

Centers for Disease Control. (2021). Blood Lead Reference Value. Page last reviewed October 27, 2021. https://www.cdc.gov/nceh/lead/data/blood-lead-reference-value.htm

Cohn, P. (2000). PCBs and Neurodevelopmental Toxicity. Interagency Workgroup on PCBs. Submitted 1998. Modified December 2000.

Das, K.P., Grey, B.E., Rosen, M.B., Wood, C.R., Tatum-Gibbs, K.R., Zehr, R.D., Strynar, M.J., Lindstrom, A.B., Lau, C. (2015). Developmental toxicity of perfluorononanoic acid in mice. *Reproductive Toxicology, 51,*133-144.

Dong, G. H., Zhang, Y. H., Zheng, L., Liu, W., Jin, Y. H., & He, Q. C. (2009). Chronic effects of perfluorooctanesulfonate exposure on immunotoxicity in adult male C57BL/6 mice. *Archives of toxicology, 83,* 805-815.

Fawell, J.K and James, H.A. (1994). Toxins from blue-green algae: toxicological assessment of anatoxin-a and a method for its determination in reservoir water. Report no. FR 0492/DoE 3728 Aug. 1994. *Foundation for Water Research*, Buckinghamshire, UK.

Fawell, J.K., James, C.P., James, H.A. (1994). Toxins from blue-green algae: toxicological assessment of microcystin-LR and a method for its determination in water. Report no. FR0395/2/DoE 3358/2 Jan. 1994. *Foundation for Water Research*, Buckinghamshire, UK

Fawell, J. K., Mitchell, R. E., Hill, R. E., & Everett, D. J. (1999). The toxicity of cyanobacterial toxins in the mouse: II anatoxin-a. *Human & experimental toxicology*, *18*(3), 168-173.

Foran, J.A. (1992). Development of Management Strategies for Contaminated Fish and Shellfish in New Jersey. The George Washington University, Washington, D.C. Report for the NJDEP, Division of Science & Research, Contract # P33487.

Humpage, A. R., & Falconer, I. R. (2003). Oral toxicity of the cyanobacterial toxin cylindrospermopsin in male Swiss albino mice: determination of no observed adverse effect level for deriving a drinking water guideline value. *Environmental Toxicology: An International Journal*, *18*(2), 94-103.

Loveless, S.E., Finlay, C., Everds, N.E., Frame, S.R., Gillies, P.J., O'Connor, J.C., Powley, C.R., Kennedy, G.L. (2006). Comparative responses of rats and mice exposed to linear/branched, linear, or branched ammonium perfluorooctanoate (APFO). *Toxicology 220*, 203–217.

Maddaloni, M. (2012). The Technical Review Workgroup for Lead. United States Environmental Protection Agency Office of Solid Waste and Emergency Response/Office of Emergency and Remedial Response (OSWER/OERR). USEPA Region 2. Personal communication with Alan Stern, NJDEP. June 22, 2012.

New Jersey Department of Environmental Protection. (2008). NJDEP - Toxicity Factors for PCBs (Polychlorinated biphenyls). September 30, 2008. https://www.nj.gov/dep/standards/1336-36-3_TF.pdf

New Jersey Department of Environmental Protection. (2017a). Basis and Background for Criteria Derivation and Practical Quantitation Levels. Ground Water Quality Standards Rule Amendments. N.J.A.C. 7:9C. New Jersey Department of Environmental Protection. December 2017. https://www.nj.gov/dep/rules/adoptions/adopt_20180116c-bb.pdf

New Jersey Department of Environmental Protection. (2017b). Recommended NJ Action Level and Health Advisory Guidelines for Recreational Exposure to Microcystin-LR, Cylindrospermopsin, and Anatoxin-A. Appendix I in: NJDEP (2018). Cyanobacterial Harmful Algal Bloom (HABs) Freshwater Recreational Response Strategy.

New Jersey Department of Environmental Protection. (2020). Review of the Basis for NJDEP Reference Doses for Cyanotoxins. April 14, 2020.

New Jersey Department of Environmental Protection. (2021). Fish Smart - Eat Smart. URL: https://www.nj.gov/dep/dsr/fish-advisories.pdf

New Jersey Drinking Water Quality Institute. (1987). Maximum Contaminant Level Recommendations for Hazardous Contaminants in Drinking Water. March 26, 1987.

New Jersey Drinking Water Quality Institute. (2015). Health-Based Maximum Contaminant Level Support Document: Perfluorononanoic Acid (PFNA). New Jersey Drinking Water Quality Institute Health Effects Subcommittee. June 22, 2015.

New Jersey Drinking Water Quality Institute. (2017). Health-Based Maximum Contaminant Level Support Document: Perfluorooctanoic Acid (PFOA). New Jersey Drinking Water Quality Institute Health Effects Subcommittee. February 15, 2017.

New Jersey Drinking Water Quality Institute. (2018). Health-based Maximum Contaminant Level Support Document: Perfluorooctane Sulfonate (PFOS). Health Effects Subcommittee. June 5, 2018.

Nisbet, I. C., & Lagoy, P. K. (1992). Toxic equivalency factors (TEFs) for polycyclic aromatic hydrocarbons (PAHs). *Regulatory toxicology and pharmacology*, *16*(3), 290-300.

Post, G., Buchanan, G., Gleason, J., Ruppel, B., Stern, A. (2018). Fish Consumption Advisory Triggers for PFOS, PFNA, and PFOA. Toxics in Biota Risk Subcommittee. 5 pp.

Post, G., Buchanan, G., Gleason, J., Ruppel, B. (2020). Fish Consumption Advisory Triggers for Microcystins, Cylindrospermopsin and Anatoxin-a. Toxics in Biota Risk Subcommittee. 10 pp.

Raatz, S. K., Silverstein, J. T., Jahns, L., & Picklo, M. J. (2013). Issues of fish consumption for cardiovascular disease risk reduction. *Nutrients*, *5*(4), 1081-1097.

Stern, A. H. (1993). Re-evaluation of the reference dose for methylmercury and assessment of current exposure levels. *Risk Analysis*, *13*(3), 355-364.

Takahashi, M., Ishida, S., Hirata-Koizumi, M., Ono, A., & Hirose, A. (2014). Repeated dose and reproductive/developmental toxicity of perfluoroundecanoic acid in rats. *The Journal of toxicological sciences*, *39*(1), 97-108.

Toxics in Biota Committee. (1994). Mercury Contamination in New Jersey Freshwater Fish. July 1994. New Jersey Department of Environmental Protection. New Jersey Department of Health. New Jersey Department of Agriculture.

Toxics in Biota Risk Subcommittee (2022). Technical Support Document: Reference Dose and Fish Consumption Triggers for Perfluoroundecanoic Acid (PFUnDA)

United States Environmental Protection Agency. (1988a). Integrated Risk Information System. p,p'-Dichlorodiphenyltrichloroethane (DDT). CASRN 50-29-3. Last updated August 22, 1988.

United States Environmental Protection Agency. (1988b). Integrated Risk Information System. p,p'-Dichlorodiphenyl dichloroethane (DDD). CASRN 72-54-8. Last updated August 22, 1988.

United States Environmental Protection Agency. (1988c). Integrated Risk Information System. p,p'-Dichlorodiphenyldichloroethylene (DDE). CASRN 72-55-9. Last updated August 22, 1988.

United States Environmental Protection Agency. (1993). Provisional guidance for quantitative risk assessment of polycyclic aromatic hydrocarbons. Cincinnati, OH: Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office.

United States Environmental Protection Agency. (1996). Integrated Risk Information System. Polychlorinated Biphenyls (PCBs). CASRN 1336-36-3. Last updated October 1, 1996.

United States Environmental Protection Agency. (1998). Integrated Risk Information System. Chlordane (Technical). CASRN 12789-03-6. Last updated December 7, 1998.

United States Environmental Protection Agency. (2000a). Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories Vol 2. EPA 823-B-00-008. URL: https://www.epa.gov/sites/default/files/2015-06/documents/volume2.pdf

United States Environmental Protection Agency. (2000b). Exposure and human health reassessment of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and related compounds. National Center for Environmental Assessment. http://cfpub.epa.gov/ncea/cfm/part3.cfm?ActType=default

United States Environmental Protection Agency. (2000c). Reference Dose for Methylmercury (External Review Draft, 2000). U.S. Environmental Protection Agency, Washington, D.C., NCEA-S-0930.

United States Environmental Protection Agency. (2001). Integrated Risk Information System. Methylmercury (MeHg). CASRN 22967-92-6. Last updated July 27, 2001. URL Accessed 7/18/2024: https://iris.epa.gov/ChemicalLanding/&substance_nmbr=73

United States Environmental Protection Agency. (2004). Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-P-Dioxin (Tcdd) and Related Compounds National Academy Sciences (External Review Draft) U.S. Environmental Protection Agency, Washington, D.C., EPA/600/P-00/001Cb, 2004.

United States Environmental Protection Agency. (2010). Development of a Relative Potency Factor (RPF) Approach for Polycyclic Aromatic Hydrocarbon (PAH) Mixtures. In Support of Summary Information on the Integrated Risk Information System (IRIS). External Review Draft. February 2010. URL: https://ordspub.epa.gov/ords/eims/eimscomm.getfile?p_download_id=494851

United States Environmental Protection Agency. (2015). Human Health Ambient Water Quality Criteria: 2015 Update. Office of Water. EPA 820-F-15-001. June 2015. URL: https://www.epa.gov/sites/default/files/2015-10/documents/human-health-2015-update-factsheet.pdf

United States Environmental Protection Agency. (2016a). Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS). Office of Water. EPA 822-R-16-004. May 2016. URL: https://www.epa.gov/sites/production/files/2016-05/documents/pfos_health_advisory_final_508.pdf

United States Environmental Protection Agency. (2016b). Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA). Office of Water. EPA 822-R-16-005. May 2016. URL: https://www.epa.gov/sites/default/files/2016-05/documents/pfoa_health_advisory_final-plain.pdf

United States Environmental Protection Agency. (2021a). Proposed Approaches to the Derivation of a Draft Maximum Contaminant Level Goal for Perfluorooctanoic Acid (PFOA) (CASRN 335-67-1) in Drinking Water. External Peer Review Draft. EPA Document Number: EPA 822D21001. November 2021.

United States Environmental Protection Agency. (2021b). Proposed Approaches to the Derivation of a Draft Maximum Contaminant Level Goal for Perfluorooctane Sulfonic Acid (PFOS) (CASRN 1763-23-1) in Drinking Water. External Peer Review Draft. EPA 822D21002. November 2021.

United States Environmental Protection Agency. (2024a). FINAL Human Health Toxicity Assessment for Perfluorooctane Sulfonic Acid (PFOS) and Related Salts. EPA Document No. 815R24007. April 2024. https://www.epa.gov/system/files/documents/2024-04/main_final-toxicity-assessment-for-pfos_2024-04-09-refs-formatted_508c.pdf

United States Environmental Protection Agency. (2024b). FINAL Human Health Toxicity Assessment for Perfluorooctanoic Acid (PFOA) and Related Salts. EPA Document No. 815-R-24-006. April 2024. https://www.epa.gov/system/files/documents/2024-04/main_final-toxicity-assessment-for-pfoa_2024-04-09-refs-formatted.pdf

United States Environmental Protection Agency. (2024c). Contaminants to Monitor in Fish and Shellfish Advisory Programs: Compilation of Peer Review-Related Information. EPA 823-R-24-001. July 2024. URL: https://www.epa.gov/system/files/documents/2024-06/contaminants-monitor-fish-peer-review-package.pdf

Van den Berg, M., Birnbaum, L., Bosveld, ATC, et al. 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. *Environmental health perspectives*, *106*(12), 775-792

Van den Berg, M., Birnbaum, L. S., Denison, M., De Vito, M., Farland, W., Feeley, M., Fiedler, H., Hakansson, H., Hanberg, A., Haws, L., Rose, M., Safe, S., Schrenk, D., Tohyama, C., Tritscher, A., Tuomisto, J., Tysklind, M., Walker, N., & Peterson, R. E. (2006). The 2005 World Health Organization reevaluation of human and Mammalian toxic equivalency factors for dioxins and dioxin-like compounds. *Toxicological sciences : an official journal of the Society of Toxicology*, *93*(2), 223–241. https://doi.org/10.1093/toxsci/kfl055

7.1 Additional relevant NJDEP publications not cited in this report

Academy of Natural Sciences of Philadelphia. (1994). Preliminary Assessment of Total Mercury Concentrations in Fish from Rivers, Lakes and Reservoirs in New Jersey. New Jersey Department of Environmental Protection, Office of Science and Research, Trenton, NJ. URL: https://rucore.libraries.rutgers.edu/rutgers-lib/59696/PDF/1/play/

Cristini, A., (1993). Dioxins in tissues from crabs from the Raritan/Newark Bay system. Division of Science and Research, New Jersey Department of Environmental Protection and Energy. URL: https://www.nj.gov/dep/passaicdocs/docs/DSRTStudies/NJDEP00016185.pdf

Baldwin-Brown, Alena and Ruppel, B. (1993). Polychlorinated Biphenyls (PCBs), Chlordane, and DDTs in Selected Fish and Shellfish from New Jersey Waters, 1988-1991: Results from New Jersey's Toxics in Biota Monitoring Program. New Jersey Department of Environmental Protection, Office of Science and Research, Trenton, NJ. URL: https://dspace.njstatelib.org/items/44e587d9-72b9-4049-ab6b-fb49e90d11d5

Belton, Thomas J. and Ruppel, Bruce E. (1982). PCBs in Fish: 1975-1980 A Comprehensive Survey. New Jersey Department of Environmental Protection, Office of Science and Research, Trenton, NJ. URL: https://rucore.libraries.rutgers.edu/rutgers-lib/31177/PDF/1/play/

Belton, T.J., Ruppel, B.E., Lockwood, K., Boriek, M., Kean, T.H., Hughey, R.E., and Burke, T.A. (1983). PCBs in selected finfish caught within New Jersey waters 1981-1982 (with

limited chlordane data). New Jersey Department of Environmental Protection, Office of Science and Research, Trenton, NJ. URL: https://dep.nj.gov/wp-content/uploads/dsr/pcbs-finfish-1981-1982-limited-chlordane-data-full-report-1983.pdf

Belton, Thomas J., Hazen, Robert, Ruppel, Bruce E., Lockwood, Keith, Mueller, Robert, Stevenson, Edward, Post, JoAnn J. (1985). A Study of Dioxin in Aquatic Animals and Sediments. New Jersey Department of Environmental Protection, Office of Science and Research, Trenton, NJ. URL: https://dspace.njstatelib.org/items/49117419-2f96-43ea-a3ce-80786f690509

Belton, T.J., (1985). Study of toxic hazards to urban recreational fishermen and crabbers. New Jersey Department of Environmental Protection, Office of Science and Research, Trenton, NJ. URL: https://rucore.libraries.rutgers.edu/rutgers-lib/31979/PDF/1/play/

FDA. (1983). Food and Drug Administration Correspondence from John Taylor (Director, Div. Regulatory Guidance) to Thomas Belton (NJDEP) outlining an Advisory Opinion on N.J. Public Health Announcements Concerning TCDD Contamination of Finfish and Crabs (12/5/83). Contained in: "A Study of Dioxin in Aquatic Animals and Sediments" Appendix B (Page 57).

Hauge, P., Bukowski, J., Morton, P., Boriek, M., McClain, J., and Casey, G. (1990). Polychlorinated Biphenyls (PCBs), Chlordane, and DDTs in Selected Fish and Shellfish from New Jersey Waters, 1986-1987: Results from New Jersey's Toxics in Biota Monitoring Program (1990) New Jersey Department of Environmental Protection, Office of Science and Research, Trenton, NJ. URL: https://dspace.njstatelib.org/items/44a64c36-6e25-4dd4-ace2-7d821a9a6e81

NJDEP (1997). A Guide to Health Advisories for Eating Fish and Crabs Caught in NJ Waters. URL: https://www.nj.gov/dep/fgw/pdf/2001/digfsh26-35.pdf

Zabik, M.E., Harte, J.B., Zabik, M.J. and Dickmann, G., (1992). Effect of preparation and cooking on contaminant distributions in crustaceans: PCBs in blue crab. Journal of agricultural and food chemistry, 40(7), pp.1197-1203. URL: https://pubs.acs.org/doi/10.1021/jf00019a024

Appendix A. History of PCB and Dioxin Fish Consumption Advisories in New Jersey.

Date	NJDEP Action	Results	Reports/Agency	Comments
1973				FDA establishes Tolerance of 5 ppm for PCBs in commercial fish.
1976	Initiated comprehensive state survey of PCBs in fish/shellfish			Discovery of PCBs in Hudson R. by NYS prompted the NJ survey.
1975-1980	Sampling/data collected on PCBs in fish	75% of fish ^{3} 0.1 ppm 2.4% > FDA of 5 ppm 11.1% > proposed FDA of 2 ppm	"PCBs in Fish: A Comprehensive Survey." NJDEP Office of Cancer & Toxic Substances Research, 1982.	Analysis for Aroclor 1254 only.
1981-1982	Additional samples collected		"PCBs in Selected Finfish with Limited Chlordane Data (1981-1982)." NJDEP Office of Science & Research, 1983.	Added Aroclor 1248 in mid-1981
1982-1983	Emergency Rule Adopted December 15, 1982 (published January 3, 1983 in NJR) FIRST PCB ADVISORIES	Fisheries closure and advisories for striped bass, American eel, bluefish, white perch and white catfish taken from the Northeast region of	Northeast Region means the region encompassing the New Jersey portion of Sandy Hook and Raritan Bays; the tidal portion of the Raritan R. upstream to Route 1 bridge in New Brunswick, Arthur	Advisories: Limited consumption (1 meal/week) of striped bass from Northeast region, inc. offshore waters in northern

Date	NJDEP Action	Results	Reports/Agency	Comments
	ISSUED (Dec 1982) (N.J.A.C. 7:25-18A)	the State. Prohibition on sale of striped bass and American eels from Hudson R., Upper NY Bay, Newark Bay, Lower Passaic R., Lower Hackensack R., Arthur Kill and Kill Van Kull.	Kill and Kill Van Kull; Newark Bay; the Passaic R. upstream to the Dundee Dam; the Hackensack R. upstream to the Oradell Dam; the New Jersey portion of the Hudson R. upstream to the NY-NJ border; and Upper New York Bay.	coastal area, American eels from entire state, esp. Northeast region, bluefish from Northeast region, inc. offshore waters in northern coastal area, and white perch and white catfish from Northeast region.
1983	NJDEP and USEPA announce results of Phase I investigation into **dioxin** in fish and crabs from the tidal Passaic River. NJDEP and DOH declare a prohibition on the sale or consumption of all fish and crabs taken from the tidal Passaic River (Administrative Order No. E0-40-17)	First Advisories based on **dioxin** issued.	"A Study of Dioxin (2,3,7,8-Tetrachlorodibenzo-p-dioxin) Contamination in Select Finfish, Crustaceans and Sediments of New Jersey Waterways." Belton et al., NJDEP, 1985.	Report details results of Phase I and II studies on Passaic R, Newark Bay, and other waterways. Observed TCDD concentrations exceed FDA "Level of Concern" (50 ppt).
1984	Administrative Order EO-40-19 (August 6,	Continued the prohibition against sale or consumption of any fish		Administrative Order based on analysis of

Date	NJDEP Action	Results	Reports/Agency	Comments
	1984)	and shellfish taken from the Passaic R. from its mouth upstream to the Dundee Dam, and additionally prohibited the sale or consumption of striped bass and blue crabs taken from Newark Bay, the tidal Hackensack, the Arthur Kill, and Kill Van Kull.		Phase II **Dioxin** study. FDA issues 2 ppm Tolerance for PCBs in commercial fish (promulgated in 1979, effective 1984)
1986-1987	Additional tissue sampling surveys of ten species.	Results consistent with previous data	"PCBs, Chlordane, and DDTs in Selected Fish and Shellfish from New Jersey Waters, 1986-1987: Results from NJ's Toxics in Biota Monitoring Program." NJDEP, 1990.	Fish sampled from the Northeast region remain the most severely contaminated.
1987	Closure of fisheries (7:25-18A.4) amended, effective March 2, 1987	No person may expose for sale, offer for sale, or sell striped bass anywhere in the state (7:25-18A.4).		
1988	NJ Fish and Wildlife Digest: Marine Fish Preparation Guidelines issued.	Advice on preparation of fish and crabs to reduce contaminant concentrations	NJ Fish & Wildlife Digest, Volume 1, No. 3, March, 1988	Advisory on crab preparation: Do not eat hepatopancreas (mustard), discard cooking water, do not

Date	NJDEP Action	Results	Reports/Agency	Comments
				use water nor mustard in any juices or sauces.
1989	1) Public notice on April 13, 1989 2) March 20, 1989 advisory signed for channel catfish.	1) Amended bluefish advisory to: (1) cover the entire coast, and (2) apply only to large bluefish (over 24 inches or 6 pounds). 2) Advisory against any consumption of channel catfish from the Delaware R. between Interstate 276 bridge and Birch Creek based on elevated levels of PCBs and/or chlordane.		
1990	Department of Health promulgated regulations on November 19, 1990 (N.J.A.C. 8:21-2.42).	Banned the sale of channel catfish taken from the Delaware River as defined above.		
1988-1991	Additional tissue sampling of ten aquatic	Results consistent with previous data	"PCBs, Chlordane, and DDTs in Selected Fish and Shellfish from NJ Waters, 1988-1991: Results from	Fish sampled from the Northeast region remain the most

Date	NJDEP Action	Results	Reports/Agency	Comments
	species.		NJ's Toxics in Biota Monitoring Program." NJDEP, 1993.	severely contaminated.
1994	Adopted new rule N.J.A.C. 7:25-14.11, March 21, 1994 Issued advisory for Raritan Bay Complex and Hudson River for Blue Crabs: "Do not eat hepatopancreas"	No person shall take or attempt to take any crabs by any means in the Newark Bay Complex (ban on harvesting crabs).	"Dioxins in Tissues from Crabs from the Raritan/Newark Bay Systems." Cristini & Gross, 1993. Report submitted to NJDEP.	New rule and new advisory based on dioxin data.
1998	"Do not eat" advisory issued for Spring Lake/Bound Brook/New Market Pond	PCBs from Cornell-Dubilier Electronics site in South Plainfield.		
1999	NJ included advisories from States of DE and PA on NJ advisory list for Lower Delaware River, Estuary, & Bay			Delaware uses a risk-based method for determining advisories.
1998-1999	Survey conducted on fish from Raritan Bay to Delaware River (PCBs,	PCBs and chlordane concentrations have decreased	"Assessment of PCBs, Selected Organic Pesticides and Mercury in Fishes from New Jersey: 1998-1999 Monitoring Program."	Data used for updating advisories.

Date	NJDEP Action	Results	Reports/Agency	Comments
	pesticides and Hg)		Academy of Natural Sciences, 2000.	
2003	2003 Fish Consumption Advisories for PCBs and Dioxin issued (PCB Advisories Updated)	Additional species and water bodies added to PCB advisory.		Revised PCB advisories are risk based using 1 in 10,000 and 1 in 100,000 lifetime cancer risk for the general population.
2004	NJ and Delaware issue consistent advisories for shared waters (Delaware Estuary); March 4, 2004	Latest advisories can be found at: http://www.state.nj.us/dep/dsr/njmainfish.htm	State issues "2004 – A Guide to Health Advisories for Eating Fish & Crabs Caught in New Jersey Waters" State issues "Fish Smart, Eat Smart" summary guide.	NJ & DE agreed to share data and reached agreement on consistent advisories for shared waters
2005	NJ issues revised advisories for the Passaic Region	Expanded advisories to additional water bodies/species for Hg and PCBs	Final Report: Routine Monitoring Program for Toxics in Fish, May 2005, Academy of Natural Sciences	Year 1 of the Routine Monitoring Program for Toxics in Fish
2006	NJ issues first advisories for winter flounder for Hudson R/Upper NY Bay & Raritan Bay (March 23, 2006)	Data based on NYSDEC results funded by the CARP program (HEP)	NYSDEC reports	Issued to coincide with opening of winter flounder season.

Date	NJDEP Action	Results	Reports/Agency	Comments
2006	NJ issues revised advisories for marine/estuarine waters and select freshwaters (March 30, 2006)	The Academy of Natural Science draft data and the updated advisories were posted online at the new advisory website: www.fishsmarteatsmartnj.org. State issues "2006-07 Fish Smart, Eat Smart: A Guide to Health Advisories for Eating Fish and Crabs Caught in New Jersey Waters"; also issues revised brochure: "Fish Smart, Eat Smart"	2004 Monitoring Program for Chemical Contaminants in Fish from the State of New Jersey *Second Year of Routine Monitoring Program.* Dec 2006, Academy of Natural Sciences submitted to NJDEP Div. of Science, Research & Technology	NJ & DE issued consistent (revised) advisories via separate press releases in April; Year 2 of the Routine Monitoring Program for Toxics in Fish
2009	NJ issues revised fish advisories for the Raritan Region		Routine Monitoring of Toxics in New Jersey Fish, Third Year (2006) of Routine Monitoring Program, Dec 2008. Academy of Natural Sciences submitted to NJDEP Div. of Science, Research & Technology.	Year 3 of the Routine Monitoring Program for Toxics in Fish
2009	NJ issues revised fish advisories for Bluefish (June 2009)			First successful multi-state coordinated effort for consistent fish advisories in the

Date	NJDEP Action	Results	Reports/Agency	Comments
				nation.
2010	NJ issued revised fish advisories for the Atlantic Coastal Plain Region (May 2010)		Routine Monitoring of Toxics in New Jersey Fish, Fourth Year (2007) of Routine Monitoring Program Atlantic Coastal Region Academy of Natural Sciences submitted to NJDEP Office of Science, Nov 2009.	Year 4 of the Routine Monitoring Program for Toxics in Fish
2012-2013	NJ issues revised fish advisories for the Upper & Lower Delaware Region		Routine Monitoring of Toxics in New Jersey Fish : Year 5, The Upper and Lower Delaware River Region and Associated Tributaries including Delaware Lake and Delaware River Basin Commission (DRBC) Traditional Sample Sites	Year 5 of the Routine Monitoring Program for Toxics in Fish Academy of Natural Sciences submitted to NJDEP Office of Science, Jan 2013.
2014-present	Internal NJ routine fish tissue monitoring program samples annually for PCBs in primarily benthic species			Annual advisories are updated/developed based on routine results and published online.