Bureau of Health Fish Tissue Action Levels
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Following USEPA's three volume Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, (EPA 1993, 1997) the Maine Bureau of Health uses action levels as a guide to determine the need for developing fish consumption advisories. Action levels are concentrations of a contaminant in fish tissue below which there should be negligible risk of toxicity at a consumption rate of one meal a week. Action levels may be developed for several different toxicological endpoints (cancer, developmental, and other non-cancer effects). Concentrations of contaminants in fish tissue are compared to the appropriate action levels. When fish tissue concentrations exceed action levels, the development of Fish Consumption Advisories are considered. This document briefly describes the derivation of fish tissue action levels and includes a tabulated summary of chemical specific fish tissue action levels currently in use by the Bureau of Health. For more details on risk based approaches for developing fish consumption advisories consult EPA's three volume Guidance for Assessing Chemical Contamination Data for Use in Fish Advisories (EPA 1993, 1997).

Derivation of Action Levels for Noncarcinogenic Toxicological Endpoints

Fish Consumption Advisories based on noncarcinogenic toxicological endpoints are set at a level believed to represent a minimal risk of a deleterious effect from lifetime exposure even for sensitive subpopulations. It is assumed that noncarcinogenic toxicological endpoints have a threshold response (i.e., there is a dose below which toxic effects will not occur). Fish Consumption Advisories are set such that total exposure from eating on average one 8 ounce fish meal per week will result in a daily dose below the threshold.

The equation (EPA 1997) for determining action levels for noncancer toxicological endpoints is:

$$AL = \frac{(RfD \times BW)}{FC}$$

Where,

AL = Action Level (mg/kg)
RfD = Reference Dose (mg/kg-day)
BW = Body Weight (kg)
FC = Fish Consumption Rate (kg/day)

The *reference dose* (**RfD**) is defined by the EPA (1997) as an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure level (mg/kg-day) for the human population, including sensitive subpopulations, that is likely to be without an

appreciable risk of deleterious effects during a lifetime. The value of the RfD is chemical and toxicological endpoint specific. The lower the value of the RfD, the more toxic the substance.

USEPA maintains databases of RfDs the Agency has derived over the years. USEPA's premier database for toxicological data including RfDs is called IRIS (Integrated Risk Information System). RfDs listed on IRIS have undergone an Agency wide review and are viewed as USEPA's preferred toxicological data. RfDs for chemicals not listed in the IRIS database can sometimes be found in the USEPA's Superfund Program HEAST (Health Effects Assessment Summary Tables) database. USEPA's Office of Pesticide Programs (OPP) also maintains a database for RfDs and other toxicological data for pesticides. It is the Maine Bureau of Health's preference to look first to IRIS as a source for toxicological data, followed by HEAST and OPP listings. Absent toxicological data on IRIS, HEAST, or OPP databases, the Bureau of Health will consider other sources (such as the Agency for Toxic Substances and Disease Registry *Minimal Risk Levels*) or derive RfDs directly from the primary toxicity data following standard risk assessment methods as described in USEPA Guidance (EPA 1997). Additionally, the Bureau of Health may derive RfDs if existing USEPA RfDs are considered outdated or do not reflect important new information.

The estimated *body weight* (**BW**) of the exposed individual is required in the action level calculation since the RfD is expressed on a "per kilogram body weight" basis. The average body weight for adult males and females combined is assumed to be 70 kilograms (kg). For adult females, the average body weight is assumed to be 60 kg. These values are supported by the following sources:

- EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (1993) recommends a mean body weight of 70 kgs for all adult and a body weight of 65 kgs for adult females.

- EPA's Draft Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (1999b) recommends a mean body weight of 72 kgs for all adult and a body weight of 65 kgs for adult females. It further recommends a value of 64 kgs for women of reproductive age.

- EPA's Exposure Factors Handbook (1999a) recommends an adult body weight of 71.8 kgs. Body weights for women in various age groups include 65.4 kgs for women 18 to 75; 60.6 kgs for women 18 to 25; and 64.2 for women 25 to 35.

The 70 kg adult general population body weight is used for all action level calculations except for chemicals in which the RfD is based on reproductive or development effects. The 60 kg adult female body weight is used for calculating action levels for reproductive and developmental toxicants. The Bureau of Health plans to review these values when EPA's draft guidance becomes finalized.

A *fish consumption rate* (**FC**) of one eight ounce (227 grams) meal per week is used to derive action levels (EPA 1997). One fish meal per week is equivalent to an average daily fish consumption rate of 0.0324 kg/day. This consumption rate is an upper estimate of sport fish consumption and is supported by the following sources.

- EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (EPA 1997) recommends a meal size of eight ounces (227 grams) as an average meal size for adults in the general population eating noncommercial caught fish.

- This same guidance (EPA 1997) also recommends a consumption rate of 0.0065 kg/day in calculating action levels, but states this value is under review. The new draft guidance (EPA 1999b) has increased the consumption rate to 0.016 kg/day for recreational fishers. They explicitly state, however, that these are recommended default rates and when local consumption rate data are available they should be chosen preferentially.

- EPA's Exposure Factors Handbook (EPA 1999a) recommends a consumption rate of 0.025 kg/day as a 95th percentile value for recreational anglers. This is based several individual studies of Maine and Michigan sports anglers (Ebert et al. 1993; West et al. 1989 and West et al. 1993).

- The 95^{th} percentile values from these individual studies range from 0.026 kg/day for Maine anglers (Ebert et al. 1993 and Chemrisk 1992) to 0.039 kg/day for Michigan anglers (West 1989).

Based on this data, it is judged that a meal size of 0.0324 kg/day is conservatively representative of an upper level fish ingestion rate for Maine recreational anglers.

Derivation of Action Levels for Carcinogenic Effects

Fish Consumption Advisories based on cancer effects are set at a level believed to represent a minimal risk of cancer from a lifetime of exposure. The Bureau of Health estimates a lifetime of 70 years (EPA 1993). There is data that suggests the upper bound estimate of residency for a particular location may be 30 years (EPA 1999a), however, the same source acknowledges that the majority of moves are less than 100 miles from the previous residence. This suggests that while an estimate of residency may only be 30 years, one may still live within commuting distance to favorite fishing sites.

Carcinogens are assumed to act in a non-threshold manner - in that any amount of exposure to a carcinogen can cause an increase in risk. Historically, incremental lifetime risk levels that have received regulatory attention range from 1 in 10,000 to 1 in 1,000,000 (EPA 1997). The Maine Bureau of Health has historically based Fish

Consumption Advisories on a 1 in 100,000 Acceptable Risk Level[1] for individual chemicals.

The equation for determining action levels for cancer effects is:

$$AL = \frac{(RSD \times BW)}{FC}$$

Where,

AL = Action Level (mg/kg)
BW = Body Weight (kgs)
FC = Fish Consumption Rate (kg/day)
RSD = Risk Specific Dose (mg/kg-day)

and,

$$RSD = \frac{ARL}{CSF}$$

Where,

ARL = Acceptable Risk Level (unitless)
CSF = Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$

Body weight and fish consumption rate are previously defined. The acceptable risk level is defined above as (1 in 100,000).

The *cancer slope factor* (**CSF**) is derived by USEPA, usually but not always, as the 95th percent upper confidence limit of the low-dose linear slope of the dose response curve and is expressed in units of $(mg/kg\text{-}day)^{-1}$. The CSF is most often derived from studies of laboratory animals, traditionally by application of dose-response models that assume no threshold for carcinogenic effects (i.e., any dose, no matter how small, will result in some risk) and allow for linearity in response at low dose. The value of the CSF is chemical-specific. The greater the value of the CSF, the greater the carcinogenic potency of the substance.

As with RfDs, IRIS is viewed as the primary database for obtaining estimates of cancer slope factors, with HEAST and OPP databases being used in the absence of an IRIS value. As with RfDs CSF's can be derived using standard EPA (1997) methodologies.

[1] Acceptable Risk Level is the terminology used by EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (EPA 1997). Other EPA documentation identifies this as the Incremental Lifetime Cancer Risk.

Action Levels

The following table identifies current action levels used by the Maine Bureau of Health for screening evaluations.

Environmental Toxicology Program, Maine Bureau of Health
UPDATED: 5/01

FISH TISSUE ACTION LEVELS FOR SCREENING EVALUATIONS (Fillet, wet weight).					
	Reference Dose (RfD) (mg/kg/d)	**Cancer Potency Factor (CPF) $(mg/kg/d)^{-1}$**	**Risk Specific Dose (RSD) (mg/kg/d)**	**Cancer Action Level**	**NonCancer Action Level**
Chlorinated Biphenyls, Dioxins, and Furans				**(ppb)**	**(ppb)**
PCBs	2.0×10^{-5}	2	5.0×10^{-6}	11	43
Dioxin [a]	1.0×10^{-9}	14000	7.1×10^{-10}	0.0015	0.0019
Polycyclic Aromatic Hydrocarbons (PAHs)				**(ppb)**	**(ppb)**
Benzo(a)pyrene Equivalence		7.3	1.4×10^{-6}	3.0	
Acenaphthene	6.0×10^{-2}				130
Anthracene	3.0×10^{-1}				648
Fluoranthene	4.0×10^{-2}				86
Fluorene	4.0×10^{-2}				86
Biphenyl	5.0×10^{-2}				108
Naphthalene	2.0×10^{-2}				43
Pyrene	3.0×10^{-2}				65
Chlorinated Pesticides				**(ppb)**	**(ppb)**
Hexachlorobenzene	8.0×10^{-4}	1.6	6.3×10^{-6}	14	1728
Heptachlor	5.0×10^{-4}	4.5	2.2×10^{-6}	5	1080
Aldrin	3.0×10^{-5}	17	5.9×10^{-7}	1.3	65
Mirex	2.0×10^{-4}				432
Lindane	3.0×10^{-4}	1.3	7.7×10^{-6}	17	648
Heptachlor/Epoxide	1.3×10^{-5}	9.1	1.1×10^{-6}	2.4	28
Toxaphene	3.6×10^{-4}	1.1	9.1×10^{-6}	20	778
Chlordane/Nonachlor	6.0×10^{-5}	1.3	7.7×10^{-6}	17	130
Dieldrin	5.0×10^{-5}	16	6.3×10^{-7}	1.4	108
DDT	5.0×10^{-4}	0.34	2.9×10^{-5}	64	1080
Endosulfan	6.0×10^{-3}				12963
Metals				**(ppm)**	**(ppm)**
Arsenic (inorganic) [b]	3.0×10^{-4}	1.5	6.7×10^{-6}	0.014	0.6
Cadmium	1.0×10^{-3}				2.2
Chromium VI	5.0×10^{-3}	3.0×10^{-3}	3.3×10^{-3}	7	11
Lead [c]					
Manganese	1.4×10^{-1}				302
Methylmercury - developmental	1.0×10^{-4}				0.2
Methylmercury - adult (paraesthesia)	3.0×10^{-4}				0.65
Nickel	2.0×10^{-2}				43
Selenium	5.0×10^{-3}				11
Silver	5.0×10^{-3}				11
Tributyl Tin (Oxide)	3.0×10^{-4}				0.6
Vanadium [d]	3.0×10^{-3}				6
Zinc	3.0×10^{-1}				648

RfD: reference dose
RSD: risk specific dose
CPF: cancer potency factor
NB: Action levels are the fish tissue concentration that allow a consumption rate of one 8 ounce meal per week for an adult without exceeding either an Rfd or a 10^{-5} Acceptable Risk Level
[a] These are BOH derived values (Frakes 1990) scheduled for review upon completion of EPA's draft health assessment for dioxin.
[b] The action levels are for inorganic arsenic. Fish tissue data are usually given as total arsenic, the BOH uses FDA's (1993) assumption that 10% of the total arsenic in fish is inorganic arsenic.
[c] For lead, action level derived by using EPA's IEUBK model for lead, with fish 17% of dietary meal intake; 95% prob. blood lead < 10 µg/dL in children.
[d] For vanadium, RfD based on ATSDR's intermediate-duration MRL.

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