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FATTY ACIDS AND MERCURY IN SEVENTY SEVEN SPECIES OF COMMERCIALLY AVAILABLE FINFISH IN THE UNITED STATES

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FATTY ACIDS AND MERCURY IN SEVENTY SEVEN SPECIES OF COMMERCIALLY AVAILABLE FINFISH IN THE UNITED STATES

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With thanksgiving for my Savior who has extended His grace, torn down the idol of career, and shown me true life and community.

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Over the past two years, I've gone through many ups and downs. Some days have been great, and I've felt like there was nothing I couldn't accomplish, while other days, I felt quite inept and discouraged. And though these feelings are common to graduate students in any discipline, I could not have completed this project or these studies without the constant love and support of my wife, Mary Ann. She provided a patient ear and constant encouragement, especially on the tough days. She celebrated my successes and commiserated in my failures, all of which led to me being able to rise each day and tackle new challenges. I cannot thank her enough for helping me get through each and every day during this chapter of my life.

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LIST OF ABBREVIATIONS

Abbreviation	Extended
AAS	Atomic absorption spectroscopy
AD	Alzheimer's disease
ALA	α-linolenic acid (C18:3n3)
ARA	Arachidonic acid (C20:4n6)
ARS	Agricultural Research Service
BHT	Butylated hydroxytoluene
bw	Body weight
CAD	Coronary artery disease
CHD	Coronary heart disease
CH_3Hg^+	Methylmercury
COX	Cyclooxygenase
CVAAS	Cold vapor atomic absorption spectrometry
CVD	Cardiovascular disease
DDT	Dichlorodiphenyltrichloroethane
DGA	Dietary Guidelines for Americans
DGLA	Dihomo-γ-linolenic acid (C20:3n6)
DHA	Docosahexaenoic acid (C22:6n3)

DHHS	Department of Health and Human Services
DMA-80	Direct Mercury Analyzer
DOLT-4	Dogfish liver certified reference material for trace metals
DORM-4	Fish protein certified reference material for trace metals
DPAn-3	Omega-3 docosapentaenoic acid (C22:5n3)
DPAn-6	Omega-6 docosapentaenoic acid (C22:5n6)
EFA	Essential fatty acid
EPA	Eicosapentaenoic acid (C20:5n3)
FDA	Food and Drug Administration
GC-FID	Gas chromatography-flame ionization detector
GL	Great Lakes region
GLA	γ-linolenic acid (C18:3n6)
HDL	High density lipoprotein
Hg^0	Elemental mercury
Hg^+	Mercurous mercury
Hg^{2+}	Mercuric mercury
IL-6	Interleukin-6
LA, LNA	Linoleic acid (C18:2n6)
LDL	Low density lipoprotein
LOX	Lipooxygenase
LT	Leukotriene
MA	Mid-Atlantic region
MI	Myocardial infarction

MUFA	Monounsaturated fatty acid
NE	New England region
NHANES	National Health and Nutrition Examination Survey
NND	National Nutrient Database
NW	Northwest region
n-3	Omega-3 fatty acid
n-6	Omega-6 fatty acid
PC	Phosphatidylcholine
PCB	Polychlorinated biphenyl
PCDD	Polychlorinated dibenzodioxins
PCDF	Polychlorinated dibenzofurans
PGE, PGH	Prostaglandin
PGI	Prostacyclin
ppb	Parts per billion
ppm	Parts per million
PUFA	Polyunsaturated fatty acid
RBC	Erythrocyte/red blood cell
RfD	Reference dose
RRF	Relative retention factor
RSD	Relative standard deviation
SDA	Stearidonic acid (C18:0)
SE	Southeast region
SFA	Saturated fatty acid

SW	Southwest region
TDA/AAS	Thermal decomposition amalgamation/atomic absorption spectrophotometry
TORT-2, TORT-3	Lobster hepatopancreas reference material for trace metals
TXA	Thromboxane
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
VEP	Visual evoked potential

ABSTRACT

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Finfish are consumed across the United States and constitute an important part of the American diet. However, seafood consumption can be a tenuous topic, with supporters highlighting the health benefits of eicosapentaenoic acid (EPA, C20:5n3) and docosahexaenoic acid (DHA, C22:6n3) and opponents emphasizing the neurotoxicity of methylmercury. Because all fish contain varying amounts of EPA, DHA, and methylmercury, the need for clear and unbiased information is essential to alleviate the confusion experienced by many consumers and empower them to make informed decisions regarding seafood consumption. As the market changes and more fish originate from aquaculture sources, where diets are controlled, consumer intakes of EPA, DHA, and methylmercury are changing. Thus, the goal of this project was to examine fatty acid and methylmercury content in 77 commercially available finfish species commonly consumed across the U.S.

EPA and DHA are important for the development of neurological function and eyesight in fetuses and infants, as well as heart health and the retention of cognitive abilities in aging populations. In accordance with these benefits, fatty acid profiles were determined for all collected species. EPA plus DHA content varied widely both within

and between species. The fatty acid profiles of farmed species differed markedly from those of wild-caught species. Farmed species, including channel catfish, salmon (Atlantic and Chinook), and sturgeon (green and white), exhibited high concentrations of saturated fatty acids, monounsaturated fatty acids, and n-6 fatty acids. These differences stem from the lower costs associated with incorporating these fatty acids into farm-fed diets as compared to EPA and DHA. Some farmed species (rainbow trout, salmon, and sturgeon) were found to contain high levels of EPA and DHA, though the ratio of EPA plus DHA to other fatty acids was generally lower in farmed species than wild-caught species.

In contrast to the health benefits offered by EPA and DHA, methylmercury exposure may adversely affect neurological development. For most adults consuming moderate amounts of fish, methylmercury is not a significant health hazard. Fetuses and developing infants, however, are considerably more sensitive to the neurotoxic effects of methymercury. Therefore, pregnant and nursing women should exercise caution when consuming seafood. The second half of this project examined the mercury content of all finfish collected. Total mercury content was low in most species, including salmon, Alaskan pollock, Atlantic cod, tilapia, channel catfish, and pangasius/swai, which are among the top ten species consumed in the U.S. Total mercury content was also low in all farmed species studied, though wide variations were still observed within and between species. In order to keep blood mercury levels below the USEPA RfD of 0.1 μg/kg bw-day, 27 species examined in this study should be avoided by sensitive populations. In addition, swordfish (1107 ppb) and king mackerel (1425 ppb) contained mercury levels above the FDA Action Level of 1000 ppb, meaning that consumers are not being adequately protected from high mercury species entering the marketplace.

CHAPTER 1. REVIEW OF THE LITERATURE

1.1. Seafood

1.1.1. Seafood Consumption

Seafood consumption is prevalent in many populations around the world, and the United States is no exception. In 2012, Americans consumed an average of 14.4 pounds of seafood per capita.[1] According to the National Fisheries Institute, the top ten consumed seafoods per capita were shrimp (3.800 lbs), canned tuna (2.400 lbs), salmon (2.020 lbs), tilapia (1.476 lbs), pollock (1.167 lbs), pangasius/swai (0.726 lbs), crab (0.523 lbs), cod (0.521 lbs), catfish (0.500 lbs), and clams (0.347 lbs).[2] However, seafood consumption has declined over the past decade, from an all-time high of 16.6 lbs per capita in 2004.[1] Various fish species have long been known as a good source of protein and long chain n-3 fatty acids, including eicosapentaenoic acid (C20:5n3, EPA) and docosahexaenoic acid (C22:6n3, DHA), but also contain toxicants like methylmercury and polychlorinated biphenyls (PCBs). This has led to a great deal of confusion among consumers, as they desire the health benefits from EPA and DHA, but want to avoid the potential for harm from the chemical hazards.

Many studies have performed risk-benefit analyses on fish.[3-10] Generally, the studies agree that there are significant benefits that come from consuming the long chain fatty acids in fish, but that the negative effects of methylmercury can cause harm, especially among sensitive populations, including pregnant and nursing women and young children. The main challenge is simultaneously encouraging the consumption of fish that are higher in EPA and DHA to maximize health benefits, while discouraging the consumption of fish that are higher in mercury to minimize health deficits. This has led many organizations to publish information regarding seafood consumption, including the U.S. Environmental Protection Agency (USEPA) and the U.S. Food and Drug Administration (FDA).[11] Others have created tools, like wallet cards and websites,[12, 13] to clarify consumption guidelines and assist consumers, especially those in sensitive populations, in making informed decisions regarding seafood consumption.

The Dietary Guidelines for Americans (DGA)[14] are published every five years by the U.S. Department of Agriculture (USDA) and Department of Health and Human Services (DHHS) to outline recommendations for consuming a healthy and balanced diet. The DGA recommendations are based upon current research and input from experts in different areas of food and nutrition. The most recent version, published in 2010, estimates mean seafood intake at 3.5 ounces per week.[14] The DGA recommends increasing consumption to 8-12 ounces per week, which may provide an average of 250 mg of EPA plus DHA per day. Additionally, consumption of a variety of seafood is encouraged to lower the risk of methylmercury intake. The DGA emphasize the importance of EPA and DHA for developing fetuses and infants, while also cautioning against the consumption of high mercury species.

One of the biggest challenges in effectively communicating seafood consumption advice is overcoming the abundance of negative reports in the media. A recent study examined stories regarding seafood carried by ten major U.S. media outlets over 15 years

(1993-2007).[15] During this time period, there were 310 news stories related to seafood. Of these stories, 68% focused on mercury in fish, 20% focused on the health benefits associated with fish consumption, and 12% focused on other safety concerns related to fish consumption. This means that major news outlets reported on the negative aspects of fish consumption (mercury or safety concerns) four times more often than the health benefits. The reasoning behind the imbalanced coverage could be motivated by a number of factors, but it is clear that communicating complete and unbiased information about the benefits and risks of seafood consumption to the public is extremely challenging.

1.1.2. Aquaculture

Historically, most seafood has been wild-caught, but in the past few decades aquaculture has experienced rapid growth and now accounts for half of all fish available to consumers.[16] Aquaculture is expected to continue to grow to meet the needs of expanding populations, especially as capture fishery production holds steady or declines.[17] However, while aquaculture represents an opportunity for growth in the seafood industry, there are many challenges that must be met and overcome. Chiefly, optimizing the diet of farm-fed fish is essential to the long-term success of aquaculture, as fish raised on farms receive their nutrition and contaminants solely from feed.[17] In an effort to reduce costs, fish farmers have experimented with blended diets, wherein fish are fed a mixture of low-cost lipids (e.g., canola oil) and more expensive marine oils that are high in n-3 fatty acids.[18] These diets yield more affordable products, as their fatty acid profiles are a mixture of the low-cost and marine oils.[19] Thus, farmers have recently turned to finishing diets, wherein fish are fed low-cost lipids until shortly before harvest, when the diet is switched to contain high levels of marine oils to boost the n-3 content.[17] This strategy has yielded higher quality products while keeping diet costs low.

Aquaculture has the potential to produce high quality seafood at a reasonable cost to consumers, but it is incumbent upon the farmers to regulate the diets of these species to create desirable products in the marketplace. By controlling the diet, farmers have the opportunity to create products with high concentrations of EPA and DHA, while keeping contaminant levels low.[17] As aquaculture continues to grow worldwide and more seafood in the marketplace originates from farms, dietary fatty acids obtained by fish consumers will change as the diets of aquaculture species change.

1.2. Lipids and Fatty Acids

Lipids are the most concentrated energy source in the diet, with each gram contributing approximately nine calories of energy.[20] Lipids also aid in the absorption of fat soluble vitamins A, D, E, and K.[21] Dietary lipids can be derived from plant and animal sources, with plants typically containing liquid lipids (oils) and animals containing solid lipids (fats) at room temperature. These differences are derived from the different ratios of saturated to unsaturated fatty acids, with saturated fats having higher melting temperatures than unsaturated fats.[21]

In biological systems, nearly all lipids occur in the triglyceride form, made up of a glycerol molecule bound to three fatty acids (Figure 1.1a). Free fatty acids can be cleaved from the glycerol backbone by lipase, and consist of a single chain of carbons with a carboxylic acid group on one end and a methyl group on the other. The length of the carbon chain ranges from 8-24 carbons and consists of an even number of carbon atoms

(Figure 1.1b). The varying chain lengths, coupled with the number of double bonds in each fatty acid, give lipids their structural and functional characteristics. Because saturated fatty acids (SFA) lack double bonds, they have more rotational flexibility and can pack together more tightly, leading to higher melting temperatures. Unsaturated fatty acids, especially in the *cis* configuration, have more rigid carbon chains that do not pack as easily as SFA and have lower melting temperatures. These structural characteristics play a major role in determining the ability of different fatty acids to affect different health endpoints.[21, 22]

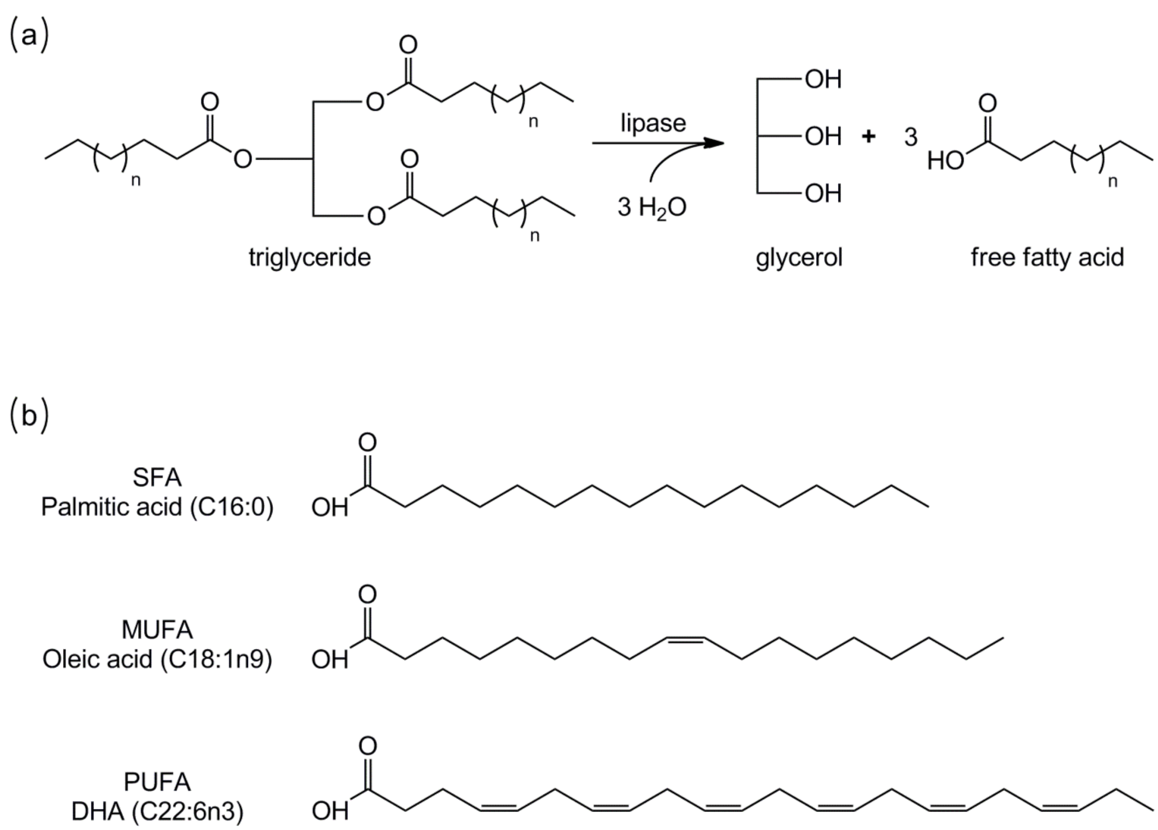

Figure 1.1 – Examples of fatty acid structure. (a) shows the lipase catalyzed cleavage of a triglyceride to form glycerol and free fatty acids. (b) shows an example of a saturated fatty acid (SFA), a monounsaturated fatty acid (MUFA), and an n-3 polyunsaturated fatty acid (PUFA).

Fish contain many different fatty acids, in various quantities. While EPA and DHA are the most important fatty acids for health, and seafood is the primary dietary source of these fatty acids, it is important to consider all fatty acids present. Thus, the following discussion will briefly review SFA, monounsaturated fatty acids (MUFA), essential fatty acids (EFA), and n-6 fatty acids before detailing the health benefits specifically associated with EPA and DHA in recent studies.

1.2.1. Saturated Fatty Acids

SFA consist of carbon chains that are completely saturated; i.e., there are no double bonds in the carbon backbone (Figure 1.1b). The most common SFA are lauric acid (C12:0), myristic acid (C14:0), palmitic acid (C16:0), and stearic acid (C18:0). Historically, SFA have been considered detrimental to health and consumption has been advised against. Practically, it is impossible to consume a diet completely devoid of SFA, as all lipids are mixtures of fatty acids. Thus, consumption advice has focused on replacing SFA with unsaturated fatty acids.[14]

SFA are derived primarily from animal and dairy sources, such as beef, pork, milk, butter, and cheese.[21] SFA are necessary for physiological functions, including tight packing in cell membranes,[23] but humans are able to synthesize them to meet physiological needs, rendering them unnecessary components of the diet.[21] The direct associations between SFA and cholesterol (total and low-density lipoproteins (LDL)) have been well established[24] and linked to an increased risk of coronary heart disease (CHD).[14, 21] Currently, Americans obtain approximately 11% of their daily energy from SFA.[14] Lowering total energy intake to 10% or less has been associated with lower cholesterol levels and decreased risk of CHD; lowering intake below 7% has shown even stronger cholesterol lowering effects.[14]

Recent reports, however, are challenging the commonly held notion that SFA have negative impacts on health.[24-29] Most reports agree that SFA levels are correlated with cholesterol levels, but also point out the correlation with high-density lipoproteins (HDL) levels. Because the ratio of total cholesterol levels to HDL cholesterol levels does not change significantly with increased SFA, the overall cholesterol balance is maintained and health deficits are minimized.[24] In addition, recent studies have been unable to find a significant link between SFA and inflammation, blood pressure, endothelial function, or arterial stiffness.[27] These results have led several researchers to conclude that although there is a link between SFA and cholesterol levels, clear and convincing evidence linking SFA levels and CHD does not yet exist.[24, 26, 27] Instead, links between SFA and other dietary components are beginning to emerge as links to CHD. Two primary confounding factors are carbohydrates and n-6 fatty acids levels. When SFA are replaced with carbohydrates, cholesterol levels rise,[29] but when SFA are replaced with polyunsaturated fatty acids (PUFA)[29] or SFA are removed with a concomitant decrease in n-6 fatty acids,[25] cholesterol levels and CHD risk are lowered. Thus, although the general consensus is that SFA are unhealthy and unnecessary components of the diet, the true effects of SFA in the diet are still being elucidated.

1.2.2. Monounsaturated Fatty Acids

MUFA contain exactly one carbon-carbon double bond along the fatty acid carbon backbone and nearly all MUFA in the diet are in the *cis* configuration (Figure

1.1b). The most common MUFA are myristoleic acid (C14:1n7), palmitoleic acid (C16:1n7), vaccenic acid (C18:1n7), oleic acid (C18:1n9), eicosenoic acid (C20:1n9), erucic acid (C22:1n9), and nervonic acid (C24:1n9). Oleic acid is the most prominent dietary MUFA, comprising 92% of total MUFA consumption.[21] Similar to SFA, MUFA can be endogenously synthesized as needed, and thus are not required from dietary sources.[21] Current opinions on the health effects of MUFA are mixed, but most studies conclude that MUFA are not harmful and may have a slight health benefit.[14, 21, 30] A "Mediterranean-style" diet has been shown to lower the risk of CHD, but the root cause of the association has not been definitively elucidated.[14] Mediterranean diets emphasize the consumption of fish, olive oil (high in oleic acid), vegetables, fruits, whole grains, moderate amounts of red wine, and small amounts of meat and dairy products.[14]

Many health endpoints have been examined in relation to MUFA, including cardiovascular disease (CVD),[30, 31] atherosclerosis,[31-33] hypertension,[34] and cancer cell proliferation.[35-38] As with SFA, the primary concern with MUFA is heart health and atherosclerosis. Atherosclerotic plaque accumulates in blood vessels as a result of high total and LDL cholesterol levels, which ultimately increases the risk of CVD.[33] Conflicting reports debate the effectiveness of MUFA on lowering total and LDL cholesterol levels, with some claiming MUFA lower atherosclerotic plaque[31, 39] and others claiming the opposite.[32, 33] This lack of agreement points to the difficulty in identifying the specific effects of MUFA, as confounding factors are impossible to eliminate. Similar ambiguity surrounds the effect of MUFA on cancer cell proliferation. Studies examined the ability of MUFA to suppress breast cancer[36, 38] and colorectal cancer[37, 40] cells, with either positive or neutral effects, leading the DGA to conclude that there is a weak association between MUFA and suppression of several types of cancer.[14] The absence of clear, independent effects of MUFA on many health endpoints has led many to conclude that MUFA may be associated with health benefits in combination with other dietary factors (e.g., PUFA), but most likely have limited impact on their own.[14, 30]

1.2.3. Polyunsaturated Fatty Acids

PUFA are the most diverse class of fatty acids, consisting of two to six *cis* double bonds in the fatty acid backbone (Figure 1.1b). With few exceptions, the double bonds in PUFA are not conjugated, but rather contain a highly oxidizable methylene carbon between each set of double bonds.[41] As the number of double bonds increases, the number of methylene carbons increases, rendering the fatty acid more susceptible to oxidation via a peroxide-generating free radical mechanism.[41] This results in oxidative rancidity, which leads to rapid food spoilage and is a major challenge to overcome with foods like fish that have high levels of PUFA.

Due to the large variations in PUFA structure and subsequent function in humans, it is impossible and inappropriate to discuss them collectively. The two main classes of PUFA are n-3 and n-6 fatty acids, which are defined by the presence of the first *cis* double bond occurring at the third or sixth carbon, respectively, from the omega (methyl) end of the fatty acid. The major n-3 fatty acids are α-linolenic acid (ALA, C18:3n3), stearidonic acid (SDA, C18:4n3), eicosapentaenoic acid (EPA, C20:5n3), docosapentaenoic acid (DPAn-3, C22:5n3), and docosahexaenoic acid (DHA, C22:6n3). The major n-6 fatty acids are linoleic acid (LA, C18:2n6), γ-linolenic acid (GLA, C18:3n6), dihomo-γ-linolenic acid (DGLA, C20:3n3), arachidonic acid (ARA, C20:4n6), adrenic acid (C22:4n6), and docosapentaenoic acid (DPAn-6, C22:5n6).[21, 42] LA and ALA are considered "essential" fatty acids (EFA) because humans cannot endogenously synthesize them; they must be obtained from dietary sources. LA and ALA can be converted to ARA, EPA, and DHA, but the conversion is very inefficient.[43] Because of this, EPA and DHA are often considered "physiologically" or "conditionally" EFA and must be obtained from dietary sources to meet recommended levels.[44]

1.2.3.1. N-3 and N-6 Fatty Acids

N-3 and n-6 fatty acids are important for a variety of health functions. N-3 fatty acid intakes are lower than recommended in the Western diet,[45] leading many to recommend increased consumption levels.[14, 21] ALA is present in many nuts and fruits, but the longer chain n-3, EPA and DHA, are obtained primarily from seafood.[14] In contrast, n-6 fatty acid intakes are much higher than recommended in the Western diet, and can be obtained from many sources, including vegetable oils.[14]

N-3 and n-6 fatty acids are necessary components of the diet, but balanced intake is critical as these fatty acids compete for the same substrates and enzymes.[46] EFA exhibit less potent physiological effects than their metabolites (ARA, EPA, and DHA) and thus must be metabolized to exhibit the maximum biological effect.[21] However, as shown in Figure 1.2, LA and ALA compete for the same desaturase and elongase enzymes during metabolism.[45] When the diet is properly balanced (i.e., the n-6:n-3 ratio is between 1:1 and 4:1[45]) and LA and ALA are consumed at appropriate levels, the body will exist in an optimal, homeostatic state. In Western diets, the n-6:n-3 ratio exceeds 15:1,[45] which may have detrimental effects on health.

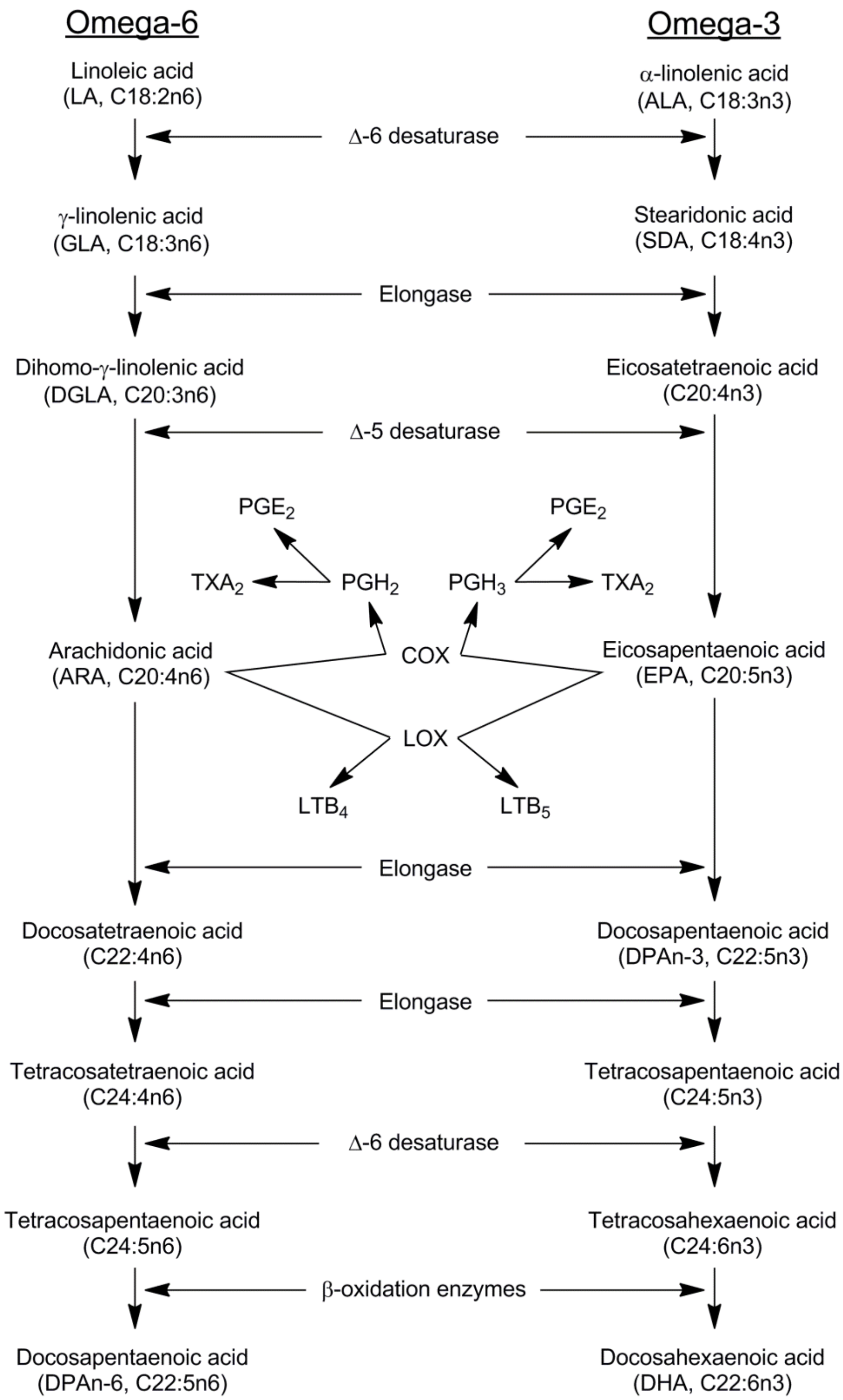

Figure 1.2 – Metabolism of essential fatty acids (LA and ALA) to ARA, EPA, DPA, and DHA.[47] Oxidative metabolism of ARA via cyclooxygenase (COX) and lipooxygenase (LOX) forms pro-inflammatory and angiogenetic prostaglandins (PGH_2 and PGE_2), thromboxane (TXA_2), and leukotriene (LTB_4). Oxidative metabolism of EPA forms compounds that inhibit inflammation and angiogenesis (PGH_3, PGE_3, TXA_3, and LTB_5).[43, 46]

PUFA are incorporated into cell membranes and have major roles in membrane fluidity, synthesis of eicosanoids and docosanoids, and regulation of membrane-bound protein signaling.[48, 49] Cell membranes with adequate concentrations of n-3 phospholipids embedded in them will exhibit more flexibility and have the ability to regulate waste, nutrient flow, and inflammation.[48] Excessive concentrations of n-6 fatty acids will displace the n-3 fatty acids and rigidify the cell membrane, rendering the cell more susceptible to injury.[48]

Due to their biological necessity in cell membranes and the modulatory effects n-3 and n-6 fatty acids exert on each other, many health outcomes have been associated with both classes of PUFA. N-6 fatty acids are recognized as pro-inflammatory agents[45, 49] that have been correlated with an increased risk of angiogenesis[46] and cancer.[21, 23] N-3 fatty acids, on the other hand, are anti-inflammatory agents[45, 49] with protective functions against CVD,[50, 51] arrhythmia,[50] thrombosis,[21] and angiogenesis.[46] Additionally, n-3 fatty acids have been associated with improved visual acuity[52, 53] and cognitive function.[43, 52] Because each of these health endpoints is specifically linked to individual fatty acids, rather than all n-3 or n-6 fatty acids, the major PUFA will be discussed below to clarify the distinct health attributes of each fatty acid.

1.2.3.2. Essential Fatty Acids

As mentioned earlier, humans cannot synthesize EFA and must obtain them from dietary sources. LA is the parent compound of the n-6 fatty acid family, with ARA being the main metabolite of physiological interest.[46] LA is present in many foods, including plant-based oils, nuts, and chicken fat.[54] ALA is the parent compound of the n-3 fatty acid family, with EPA and DHA being the most bioactive metabolites.[46] The ALA content of many foods is low, though chia seeds, flax seeds, canola oil, and several other plant-based oils contain appreciable amounts.[55] Although LA and ALA are essential components of the diet, the literature is lacking studies about the direct effects of these fatty acids. Most reports examine the effects of varying LA or ALA intake on the production of ARA, EPA, and DHA or other health endpoints. Because the effects of LA and ALA are difficult to determine in isolation, EFA are commonly discussed in broader terms, i.e., they are discussed as members of the n-3 and n-6 families or as PUFA, and the same approach will be employed here.

1.2.3.3. Arachidonic Acid

1.2.3.3.1. Inflammation

ARA is a pro-inflammatory agent that competes with EPA for cyclooxygenase (COX) and lipooxygenase (LOX) enzymes (Figure 1.2).[46] ARA and EPA are metabolized by COX-2, 5-LOX, and 12-LOX to form leukotrienes (LT), prostaglandins (PGE and PGH), prostacyclins (PGI), and thromboxanes (TXA).[45, 46, 56] When ARA is metabolized to one of these products, different physiological responses are observed: LTB_4 and PGE_2 induce inflammatory responses, while TXA_2 causes vasoconstriction and is a strong platelet aggregator.[56] Atherosclerosis is initiated by an increase in inflammation,[57] potentially leading to CHD and other heart problems.[45] Additionally, pro-inflammatory cytokine production is elevated by ARA.[58] Interleukin-6 (IL-6) is considered a highly potent cytokine, as it can stimulate the synthesis of multiple inflammatory response proteins.[59] The inflammatory response of IL-6 has been linked to CVD via increased platelet aggregation and the acute phase response of the liver.[60] Finally, the increased inflammatory response of ARA metabolites PGE_2, PGI_2, PGH_2, and TXA_2 (via the COX-2 enzyme pathway) have been shown to promote angiogenesis and subsequent tumor growth.[61] With the current imbalance of n-6 fatty acids in the Western diet, the inflammatory properties of ARA have led to increased health concerns.[49]

1.2.3.3.2. Cognitive Function

In contrast to the potentially negative effects ARA exhibits as a pro-inflammatory agent, ARA is an essential components of neuronal cell membranes.[62] Many studies have been performed to test the impact of ARA on neurological function. Three recent studies examined the effect of ARA on neurophysiology, and found that ARA increased hippocampal neuronal membrane fluidity (which may provide a protective effects in aging neurons),[63] exhibited a dose dependent protective effect against glutamate and hydrogen peroxide,[64] and was metabolized more rapidly under the deprivation of DHA, leading to higher levels of neuronal inflammation and excitotoxicity.[65] Other studies investigated the effects of ARA on cognitive outcomes in humans and rats. ARA was correlated with improved maze performance in senescent rats[66] and higher levels of cognitive performance in infants.[62] Neurodegenerative conditions, such as Alzheimer's disease (AD),[67] bipolar disorder,[68] and major depression,[56] have all been shown to interfere with ARA metabolic cascades in the brain. These studies lend credence to the positive benefits of ARA and show that it is a necessary component of a balanced diet with appropriate amounts of n-3 and n-6 fatty acids.

1.2.3.4. EPA and DHA

EPA and DHA are generally recognized as the most important fatty acids for health, but also the most deficient in the Western diet.[14] As discussed below, deficiencies in EPA and DHA have been associated with an increased risk of CVD, cognitive and visual deficits, and other health endpoints. CVD in particular is higher in Western populations than it is in those consuming a "Mediterranean diet".[51] This difference is thought to derive from the combination of high levels of fish and olive oil consumption and low levels of meat consumption in Mediterranean populations, which will increase EPA and DHA intake while lowering the overall n-6:n-3 ratio.[14] With the myriad health endpoints evaluated in association with EPA and DHA, the discussion below covers the major areas of research. Although EPA and DHA have shown protective effects against several types of cancer (notably breast,[69] prostate,[70] and colorectal[71] cancers), hepatosteatosis,[72] and angiogenesis,[46] these are developing areas of research that are beyond the scope of this review. Here, an overview of seminal studies related to major health endpoints and exemplary studies published in the past two years are highlighted.

1.2.3.4.1 Cognitive Development and Neurological Function in Infants

The mammalian brain consists of high levels of stearic acid, ARA, and DHA, with structural and functional decline observed in DHA-deficient neuronal cell membranes.[73] Many studies have been performed to investigate the effects of these fatty acids on cognitive outcomes.[43, 52, 74] Positive correlations have been observed between n-3 PUFA and cognitive development in animal models, though mixed results have been seen in human studies, perhaps stemming from experimental design flaws.[43] It is possible that these mixed findings are due to the short time frame over which many of these studies are conducted; many evaluate very short infant n-3 PUFA supplementation time periods and then re-evaluate the infants less than one year later. Intelligence tests are difficult to design, conduct, and interpret in infants less than 12 months old, which may affect the reliability of these studies.[75]

A recent study by Mulder et al. examined the effects of DHA supplementation on fetuses from 16 weeks gestational age to term.[76] A total of 270 pregnant women were randomized to DHA supplementation (400 mg/day) or placebo groups. The women in the two groups were not significantly different in measures of intelligence quotient or educational background. Post parturition, the children were examined at 2, 9, 12, 14, 16, and 18 months for a variety of markers of cognitive development and visual acuity. Infants in the placebo group exhibited lower language development (a measure of cognitive function) and lower scores on tests of visual acuity than the DHA supplemented infants. These results were consistent across many different testing methodologies throughout the study period, leading the authors to conclude that there is a significant benefit to gestational DHA supplementation.[76]

In another recent study by Colombo et al., the effects of infant DHA supplementation from birth to 12 months was examined.[77] However, in contrast to most studies, the children in this study were evaluated on a variety of cognitive ability tests every six months, from 18 months to 6 years of age. Although no significant differences were noted at 18 months, some measures exhibited differences starting at 3 years of age, indicating that the true effects of DHA supplementation may not be apparent until later in development. Tests of attention, rule learning and implementation ability, and verbal ability were all positively correlated with DHA supplementation, while tests of spatial memory and advanced problem solving did not exhibit significant results. Overall, this study demonstrated that a finite period of infant DHA supplementation (birth to 12 months) had positive effects on cognition up to 6 years of age. This led the authors to conclude that DHA intake during infancy has cognitive benefits into childhood.[77]

Beyond the cognitive benefits of n-3 PUFA during gestation and infancy, n-3 PUFA have also been shown to protect gestation and post parturition neurons against cell death via apoptosis in hyperoxic environments.[78] Tuzun et al. examined the effects of fetal rats receiving EPA and DHA and their post-birth responses to hyperoxic environments (80% oxygen) for five days. Six groups of rats (6 rats per group) were treated under different conditions to determine if varying levels of n-3 PUFA supplementation provided protection against hyperoxic environments. The study revealed that a maternal diet deficient in n-3 PUFA as well as early postnatal hyperoxia exposure induced neuronal cell death via apoptosis.[78] This study illustrates the important and relatively unexplored neuroprotective abilities of n-3 PUFA, particularly DHA, in developing brains. Because neurons are susceptible to cell death by reactive oxygen species throughout life,[79] the ability of DHA to protect against apoptotic mechanisms (by scavenging free radicals in the brain[73, 80]) is significant, as it provides new insights into possible mechanisms and solutions for maintaining neuronal cell function throughout life.

1.2.3.4.2. Preservation of Neurological Function in Aging Populations

Studies have also been performed in aging populations and found that DHA provides a neuroprotective, and potentially therapeutic, effect against AD, dementia, and other neurodegenerative conditions that are common in seniors.[43, 81] Because normal aging processes in the brain are characterized by increased oxidative stress, increased inflammation, and altered metabolic states,[82] DHA's neuroprotective effects have been mechanistically tied to inflammation inhibition, cell membrane fluidity increases, preservation of synaptic function and signaling pathways, and increases in neurogenesis.[83] AD, in particular, has been correlated with decreases in n-3 PUFA levels in the brain.[84] There have also been reported links between n-3 PUFA and Parkinson's disease, though the evidence is considerably weaker.[73, 84]

The longest running epidemiological study in history is the Framingham Heart Study, which was originally designed to investigate causes of CHD. It has been continued over three generations and now monitors additional health endpoints, including dementia, stroke, and other diseases.[85] Correlations have been found between CVD risk factors and neurodegenerative diseases, stemming from the monitoring of health changes over time and the evaluation of post-mortem brain physiology.[85] The Framingham study has been able to connect various risk factors to cognitive aging and dementia. One important predictor is plasma phosphatidylcholine DHA concentration (PC DHA, a neurological metabolite of DHA), which was associated with a 47% lower risk of dementia development in the highest quartile of participants.[86]

AD is responsible for 80% of all dementia diagnoses, leading many researchers to focus on the specific relationship between n-3 PUFA and AD, rather than all-cause dementia.[87] Although the literature contains mixed results regarding the effect of n-3 PUFA and AD, no studies have shown a negative effect of n-3 PUFA on AD.[88] A recent study by Phillips et al. evaluated the effects of lower levels of EPA and DHA intake on three patient populations of individuals 55-91 years of age: healthy, non-dementia related cognitive impairment, and AD.[89] By comparing individuals of the same age and gender across the three groups, the healthy individuals performed significantly better than other participants in 18 of 20 tests. In all 18 tests, AD participants had the poorest performance, with cognitively impaired participants scoring between the two groups. These results were compared to plasma PC EPA and DHA levels; both were found to be significant predictors of memory. It was also noted that healthy participants consumed higher levels of n-3 PUFA, though this observation was not thought to be a causal component of the observed relationships. Based on the relationships between n-3 fatty acids and mental health status, this study concludes that n-3 fatty acids may play a role in cognitive function, though these results only show a correlation and not a causation between EPA and DHA and AD.[89]

All aging individuals suffer from cognitive decline to some extent, though this may be mitigated by n-3 PUFA.[90] Recent work has shown that mitigation is most effective when EPA and DHA is consumed consistently over a lifetime, rather than introduced late in life as an intervention.[90] Tan et al. recently examined a cohort of 1575 elderly, dementia-free individuals from the Framingham study and correlated circulating levels of erythrocyte (RBC) EPA and DHA with markers of brain aging.[91] RBC levels of DHA were positively correlated on three of the four tests performed to assess cognitive aging. The quartile with the lowest RBC DHA levels performed more poorly than individuals in the other quartiles. Magnetic resonance imaging revealed lower brain volumes and evidence of accelerated structural and cognitive aging equivalent to approximately two additional years of neurological aging in participants with lower RBC levels of DHA and EPA.[91] Brain aging has been associated with an increased risk of vascular complications, stroke, and dementia,[92] which may render individuals with lower RBC levels of EPA and DHA vulnerable to an earlier onset of these conditions.

1.2.3.4.3. Eyesight and Visual Acuity

The development of eyesight in fetuses and infants relies on the same fatty acids (DHA and ARA) as developing neurons. These fatty acids are prominent components of the retina, without which, deficits in retinal rod photoreceptor development may be observed.[93] Positive correlations between EPA and DHA levels in the blood and performance on tests of visual acuity have been observed in many studies.[53, 62, 94, 95] These studies compared the effects of fatty acids obtained from breast-feeding and formula-feeding in infants at different time points. It was determined that breast-feeding almost always provides the necessary ARA and DHA for proper retinal development, while formulas must incorporate DHA of at least 0.32% of total fatty acids; addition of equivalent or larger amounts of ARA enhances the observed effects.

Nearly all recent studies related to the development of visual acuity have examined the effects of DHA on visual-evoked potentials (VEP) as well as other cognitive endpoints, thus it is difficult to find detailed results directly discussing the effects of DHA on visual acuity. However, a recent meta-analysis evaluated the results of 19 studies, encompassing 1949 infants.[96] Ten studies demonstrated a favorable effect of PUFA supplementation; the other nine studies did not find a significant result. The included studies measured the effects of infant formula on VEP and evaluated participants at many different time points during the first year of life. After accounting for all confounding factors and reanalyzing the data, a significant benefit between visual acuity and infant formula supplementation with ARA and DHA was demonstrated. Although meta-analyses have a different impact than primary research, they are valuable tools in collecting and analyzing the results of multiple studies that may have originally indicated conflicting results. This analysis draws on studies over the past two decades and demonstrates the benefit of infant formula supplemented with ARA and DHA.

Another study evaluated the effect of DHA intake in beagle puppies.[97] In this study, the puppies were weaned at eight weeks of age and then placed on an energy-matched diet with low, moderate, or high amounts of DHA for the duration of their first year of life. Serum DHA levels were the same at baseline, but significantly different at one year of age. A battery of tests was designed to measure the effect of DHA on cognition, memory, immune system function, and retinal function. Positive associations were noted for each of these endpoints. Improved activity of retinal cells was correlated with higher serum concentrations of DHA, allowing the dogs to see better under low-light conditions. Though this study was performed on dogs, it is exemplary of what is often attempted and observed with infants.

1.2.3.4.4. Heart Health and Inflammation

The effect of n-3 fatty acids on heart health was first observed in epidemiological studies on Inuits in Greenland.[98] When compared to Danish populations, the high fish consumption of the Inuits was associated with significantly lower levels of CVD, especially myocardial infarction (MI).[99, 100] Following these studies, more studies were designed to elucidate the effect of dietary n-3 on heart health. The Seven Countries

Study[101] determined associations between dietary intake and CHD mortality over a 25-year period in people from the United States, Finland, the Netherlands, Italy, Yugoslavia, Greece, and Japan. Eighteen basic food groups were examined and it was determined that fish, oils, and other vegetable products were associated with low rates of CHD. Conversely, butter, dairy, and animal products (excluding fish) were associated with high rates of CHD.[101] Another large epidemiological study, the Chicago Western Electric Study,[102] followed 2107 men for 30 years and compared heart-related deaths to dietary factors. The study found that all-cause heart-related mortality rates were lowest in men that consumed high levels of fish. Additionally, it was found that men consuming at least 35 g of fish per day had a 42% lower incidence of MI.[102] These studies were foundational works that catalyzed modern researchers to uncover the primary source of the benefit in fish, which is now known to be n-3 PUFA, and in particular, EPA and DHA.

In recent years, much work has been done to clarify the relationship between heart health and EPA and DHA. Otto et al. examined a multiethnic cohort of 2837 adults.[103] This study was particularly important because it relied upon plasma phospholipids in addition to food frequency questionnaires to determine the relationship of EPA, DPAn-3, and DHA with CVD, including CHD and stroke. Blood pressure, triglycerides, and IL-6 were also measured as indicators of inflammation. Over a 10 year period, blood levels of EPA and DHA were inversely related to CVD in all races, while DPAn-3 only exhibited a significant relationship in Chinese and Caucasian populations. No significant relationships were found with ALA or n-6 fatty acids. The authors attributed the relationship of EPA and DHA with CVD on the suppressed levels of inflammatory compounds in the blood,[103] which lowers the ability of platelets to aggregate and form atherosclerotic plaques in blood vessels.[57] While other studies have also shown beneficial relationships between EPA and DHA and CVD, this particular study not only demonstrated an ethnically homogeneous effect, but also relied on PUFA levels in the blood to draw their conclusions.[103] This is significant because most studies rely on dietary intake questionnaires to determine causal relationships. These questionnaires are useful, but rely upon participants' memories and do not take into account physiological differences between individuals that can affect fatty acids metabolism.

A similar study was performed by Mozaffarian et al. and examined plasma phospholipids in relation to CVD in elderly individuals (age 65 and older) not receiving dietary supplements and without a prior history of CVD.[104] The results were measured over a 16 year time period and were similar to those observed by Otto et al.[103] In this study, EPA, DPAn-3, and DHA were all inversely correlated with CVD. DHA was shown to give the best protection against CHD death, and DPAn-3 lowered stroke death most significantly. Although these n-3 fatty acids did not provide protection against other specific types of mortality, they did provide a 27% lower risk of all-cause mortality, which corresponded to approximately 2.2 additional years of life for persons over the age of 65. This led the authors to conclude that consuming n-3 fatty acids late in life may reduce total mortality, though there could be confounding factors present. Based on their results, the authors recommend a target intake level of 250 – 400 mg of EPA plus DHA per day to maximize cardiovascular benefits.[104]

The cardioprotective effects of EPA and DHA have been attributed to their anti-inflammatory properties and their competition with ARA for COX and LOX enzymes (Figure 1.2).[46] Just as LTB_4, PGE_2, and TXA_2 from ARA metabolism induce inflammation and vasoconstriction, the metabolites LTB_5, PGE_3, and TXA_3 from EPA metabolism decrease inflammation and induce vasodilation.[56] Additionally, the anti-inflammatory effects of EPA lower circulatory levels of the inflammatory cytokine IL-6 in the blood.[58] By removing IL-6 from the blood, EPA indirectly lowers CVD risk by inhibiting atherosclerotic plaque formation.[57] When the n-6:n-3 ratio is not properly balanced, the pro- and anti-inflammatory characteristics of ARA, EPA, and DHA will not effectively modulate physiological responses. High levels of ARA have been associated with CVD from atherosclerosis, while excessively high levels of EPA and DHA can have a blood thinning effect and inhibit a proper biological response to injury.[21]

A study by Nozue et al. examined the effects of ARA, EPA, and DHA on atherosclerosis in people with coronary artery disease (CAD).[105] After eight months, inverse relationships were observed between the change in atherosclerotic plaque volume and the EPA:ARA, DHA:ARA, and EPA plus DHA:ARA serum ratios. In patients with progressive plaque growth, EPA and DHA concentrations had decreased significantly, but in patients with regressive plaque, no change was observed. The n-3:n-6 ratio was found to be negatively correlated with the percent change in plaque volume. Additionally, indications of preferential incorporation and modulation of plaque by EPA was observed when compared to DHA, though the significance of these results was not determined.[105] This study is important because it examined the mechanistic and physiological underpinnings of PUFA levels and their effects upon previously formed atherosclerotic plaques. Understanding the mechanisms and balance of EPA, DHA, and ARA is important in the treatment and prevention of serious cardiovascular consequences.

1.2.3.4.5. Summary of Health Implications of EPA and DHA

Although the studies presented here point to the positive health benefits of EPA and DHA, not all studies observe similar results. Conflicting reports have emerged in recent years, with many studies confirming the cardioprotective effects of EPA and DHA and others finding no significant relationship.[106] Thus, there is a great need for more well-designed, large, epidemiological studies that rely upon quantifiable baseline data (like fatty acid levels in the blood) to fully understand the effects of EPA and DHA on CVD.

1.3. Mercury

1.3.1. History of Methylmercury Poisoning and Seminal Studies

Mercury has been used in industrial and mining operations for many years. However, the toxicity of methylmercury and its effects were not identified until the mid-20th century. Two devastating events that severely impacted many people in Japan and Iraq were eventually identified as methylmercury poisoning. Further studies have been performed on populations with high rates of seafood consumption. Two large, longitudinal studies on populations in the Faroe Islands and Seychelles have further elucidated the effects of methylmercury exposure in non-poisoning events. These events and the subsequent studies are the foundation upon which many regulations, safety information, and seafood consumption advisories are based.

1.3.1.1. Minamata Bay, Japan

Minamata City rests on the shores of Sea of Shiranui in southwest Japan. Minamata City was relatively unknown until the 1950s and 1960s, when a local chemical plant (Chisso Corp. Ltd.) released contaminated waste water, containing large amounts of mercury, into the Minamata River.[107] The polluted water flowed into Minamata Bay, where the mercury was absorbed in extremely high quantities by fish. This caused many obscure behaviors, including continuous rotation and floating belly-up.[107] Local birds fell in mid-flight and cats exhibited bizarre symptoms, including excessive salivation, violent convulsions, and jumping into the sea to drown.[107] Despite these behaviors, fishermen and local denizens continued to consume large quantities of fish and began experiencing debilitating symptoms that were inconsistent with previously known pathologies, thus this mysterious malady was dubbed "Minamata Disease".[108] Patients suffering from Minamata Disease experienced symptoms of varying intensity, including constriction of the visual field, sensory disturbances, ataxia, dysarthria, auditory disturbances, and tremor.[107] In several extreme cases, permanent blindness and even death occurred.[107] Many children during this period were born with mental retardation, primitive reflex, disturbances in physical development and nutrition, dysarthria, deformed limbs, hyperkinesia, and hypersalivation.[109] In contrast, their mothers experienced milder symptoms and in some cases were completely asymptomatic.[109]

Scientists eventually connected Minamata Disease to the large quantities of mercury being expelled by the Chisso Corporation. It was determined that methylmercury was being absorbed in fish at extremely high levels (upwards of 30 ppm) and was consequently ingested by humans when consuming the contaminated fish.[107] Initial pathological studies of mercury poisoning revealed the brain and central nervous system as the primary targets, with extensive, irreversible neurological lesioning observed in the most serious cases.[107] In the years after the initial cases of Minamata Disease were found, many other denizens of Minamata City were diagnosed with chronic presentations of the disease that were linked to sub-acute level exposures during the initial outbreak.[108] Decades after the initial outbreak of mercury poisoning, people were still being diagnosed with chronic forms of Minamata Disease, which, although less severe in nature, are still irreversible and tend to worsen with time.[108]

Much has been learned since the identification of mercury as the element responsible for Minamata Disease. One of the lasting effects has been the evolution and focus on food safety, as everyone exhibiting symptoms consistent with Minamata Disease consumed large quantities of highly contaminated seafood. Not long after Minamata Disease was discovered and many research studies were performed on the toxicity and pathology of methylmercury, the FDA and WHO established limits for fish and mercury consumption.[108] These limits have been modified over time, but their establishment and the subsequent focus on food safety are lasting lessons from the Minamata Bay tragedy.

1.3.1.2. Iraq

In 1972, the most widespread outbreak of methylmercury poisoning in history occurred in Iraq. During that year, 6530 people were admitted to hospitals and 459 died from methylmercury poisoning.[110] The cause of the outbreak was determined to be wheat and barley seeds treated with a methylmercury fungicide, though the final identification of methylmercury as the sole cause of toxicity was not identified for many years.[111] The seeds were used in homemade wheat flours and breads, livestock feed, and planting fields. Humans were exposed directly and indirectly, as the seeds were eaten by birds and livestock and seed disposal in local waterways contaminated the fish supply.[110]

To monitor and assess the body burden and history of methylmercury ingestion by poisoned patients, hair, blood, plasma, breast milk, and urine were monitored.[110] High concentrations of mercury were found in the hair and blood.[110] An average latency period of 21 days between food consumption and symptom exhibition was observed in addition to long *in vivo* half-lives for methylmercury (40-105 days).[110] Patients exhibited a wide variety of symptoms, similar to the Minamata patients. Mild and moderate poisoning caused ataxia, dysarthria, tremor, anxiety, and insomnia, while more severe cases included constriction of the visual field (including blindness), deficits in hearing (including deafness), dysphagia, depression, and death.[112] In contrast to the chronic cases of Minamata Disease, patients surviving acute methylmercury poisoning in Iraq were able to partially recover from their symptoms, though the majority of the neurological damage was irreversible.[112]

In addition to the adult populations studied, mother-infant pairs were examined in the aftermath of the outbreak. A study of 15 women who ingested methylmercury-laden bread while pregnant showed a general correlation of the blood mercury levels between the mother and offspring.[113] In 14 of the 15 cases, the infants exhibited higher blood mercury levels than their mothers, indicating *in utero* and postnatal breast-feeding exposed infants to large quantities of methylmercury through milk or placental transfer.[113] A follow-up study, five years later, showed that the severity of symptoms in the mother correlated well to the severity of symptoms experienced by the child.[114] However, while the mothers generally recovered from some of their symptoms, the damage to the offspring's central nervous system was permanent.[114] These studies illustrated the heightened sensitivity of fetuses and infants to methylmercury toxicity.

1.3.1.3. Faroe Islands

In the wake of the Minamata and Iraq methylmercury poisoning incidents, other sources of methylmercury came under increased scrutiny. Outside of workers in specific industrial settings, seafood is the most prevalent source of methylmercury exposure.[115, 116] Studies relating seafood consumption and health outcomes have been performed on numerous populations throughout the world. One nation that has been well studied is the Faroe Islands in the northern Atlantic Ocean. The Faroese have a long and rich fishing tradition, centering on the annual hunt for pilot whales. The whales are harvested for their meat and blubber and are a significant element of the Faroese diet, making up 9.5% of all dinners.[117] Pilot whales contain high levels of mercury (3.3 ± 1.7 ppm), about half of which is methylmercury (1.6 ± 0.4 ppm).[118] These elevated levels of methylmercury have caused concerns that methylmercury poisoning may occur, especially in fetuses and infants.

In an effort to better understand the relationship between maternal seafood consumption and its effects on developing children, a longitudinal study followed a cohort of 1022 infants born in the Faroe Islands in 1986 – 1987.[119] Maternal hair and umbilical cord blood mercury content were measured at birth.[119] The children were monitored for 14 years, with blood and hair mercury measured at seven[120] and fourteen[121] years of age. Additionally, the children were examined at both ages through a variety of tests to determine if any cognitive deficits developed as a result of *in utero* exposure to methylmercury.

At seven years of age, the children were examined on fifteen tests to measure neurophysiological and neuropsychological responses to different stimuli.[120] On all or part of eight tests, significant correlations between umbilical cord mercury levels and impaired performance were found. Though most differences were subtle in presentation, significant decreases in language, attention, memory, brainwave activity, and manual motor speed were observed with increased gestational mercury exposure. Based on their analyses, the authors concluded that several areas of the brain may be affected by *in utero* methylmercury exposure. Additionally, regression analyses indicated that a doubling of gestational mercury exposure corresponded to a developmental delay of two months for several cognitive functions.[120]

The children were reexamined at fourteen years of age to determine if the adverse neurological symptoms were still present.[121] To create the most accurate comparison, the same battery of tests was administered, with minor changes implemented to ensure the tests were age appropriate. The results of this second round of testing matched the earlier findings, i.e., cohort members with greater *in utero* methylmercury exposure exhibited impaired motor speed, attention, language, and verbal function. Hair mercury levels of the fourteen year old subjects indicated methylmercury exposure levels five times lower than prenatal exposure, leading to the conclusion that prenatal exposure deficits are permanent.[121]

1.3.1.4. Seychelles

Seychelles is a tropical island nation in the Indian Ocean. Like the Faroese, the Seychellois consider fish a dietary staple, with an average consumption of twelve fish meals per week.[122] But unlike the Faroese, the Seychellois do not consume any high mercury species; their intake of methylmercury is 10-fold lower than that of the Faroese.

To examine the potential effects of methylmercury in the Seychellois population, a longitudinal study of 779 mother-infant pairs were enrolled in 1989 and tested at six different time points over eleven years (birth, six months, 19 months, 29 months, 66 months, and 107 months).[123]

At 66 months of age, the Seychellois children were examined via seven cognitive aptitude tests.[122] Thorough statistical analyses were performed to measure correlations between pre- and postnatal exposure to environmental toxicants and cognition. Only one test showed significant deleterious effects, while several measures showed positive effects. The authors attributed the positive effects to the health benefits of seafood overcoming the negative impacts of methylmercury.[122] These results contradict the results of the Faroe Islands study, though this is most likely due to the high levels of mercury and other environmental contaminants (PCB, PCDD, PCDF, DDT, and other pesticides) in north Atlantic marine mammals.[124, 125] A follow up study on the children at ten years of age showed no significant correlations between mercury intake and cognitive function.[123] These results match the observations from earlier time points in the study, leading the authors to conclude that high intake and exposure to low mercury fish has no significant effect on development. Because Seychelles is a westernized nation, these results are important for U.S. fish consumers and indicate that high levels of fish consumption are not likely to be problematic, provided low mercury species are chosen.

1.3.2. Global Cycling of Mercury

Mercury has been used for many years in industrial processes, but a full understanding of the deposition and environmental impacts have only been elucidated in the past half-century. Mercury is a persistent environmental contaminant introduced into the atmosphere or waterways by natural (e.g., volcanoes) and anthropogenic (e.g., industrial processes and mining) sources.[126, 127] Nearly all mercury emitted in these ways is elemental mercury (Hg^0). Over time, Hg^0 is oxidized to mercuric mercury (Hg^{2+}), which is solubilized in rainwater and subsequently absorbed by aquatic sediments.[128] Once absorbed, sulfate-reducing bacteria ingest and convert Hg^{2+} to methylmercury (CH_3Hg^+).[128] This conversion is thought to be a protective mechanism against the toxic effects of Hg^{2+} in aquatic bacteria.[128] The methylated mercury is then passed from sediment back to open water, where it is absorbed by aquatic microorganisms. Methylmercury then bioaccumulates in fish as they consume the microbes (Figure 1.3).[116] Due to its long half-life in living organisms,[129, 130] methylmercury biomagnification is observed in higher trophic levels, leading to higher concentrations in large, predatory marine species.[128] As fish are harvested and consumed by humans and other animals, methylmercury is absorbed and metabolized.

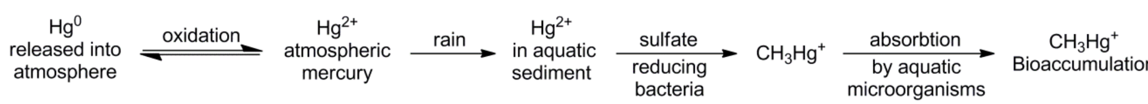

Figure 1.3 – Global cycling of mercury. Mercury is introduced into the environment from natural and anthropological sources as Hg^0 vapor. Following oxidation to Hg^{2+}, rainwater returns mercury to the earth's surface, where it is absorbed into aquatic sediment and converted to methylmercury by sulfate reducing bacteria. Methylmercury is then absorbed by aquatic microorganisms and bioaccumulates in fish.[116, 128]

1.3.3. Mercury and Human Health

1.3.3.1. Forms of Mercury

Mercury exists in two prevalent forms in nature: inorganic and organic. Inorganic forms of mercury include Hg^0, Hg^{+1} (mercurous mercury), and Hg^{+2}.[116] Inorganic mercury presents an occupational hazard for workers in industries that rely heavily on mercury for the amalgamation of metals (specifically gold) or as a reaction intermediate in production.[128] Inhaled mercury vapor is generally well absorbed and targets the lungs and central nervous system, while other forms of inorganic mercury are poorly absorbed and target the kidneys.[131]

Organic mercury forms are varied and more regularly encountered. Forms of organic mercury include methylmercury, ethylmercury, dimethylmercury, phenylmercury, and methoxymercury compounds.[128] Strict regulations have limited the use of many of these compounds in recent years, mostly due to the poisoning events in Japan and Iraq that were caused by organic mercury compounds. Ethylmercury is still used as the vaccine preservative thimerosal in developing countries, though in 2001 thimerosal was removed from vaccines in developed countries due to concerns over the potential for harm from mercury toxicity.[131] Phenylmercury compounds have been used as antiseptics in skin creams and as spermicides, while methoxymercury has been used as an antifungal seed coating.[128] These compounds have been strictly regulated and are rarely encountered today. Dimethylmercury compounds are restricted to laboratory use due to their extreme toxicity, as evidenced by the death of a Dartmouth professor after several drops spilled on her laboratory gloves.[132] Methylmercury accounts for over 95%

of the total mercury in seafood[133] and is the most prominent concern for toxic mercury substances, as fish are consumed by billions around the world.

1.3.3.2. Methylmercury Toxicokinetics

Methylmercury absorption can occur via several pathways. For adults and children, consuming fish is the primary source of exposure, while fetal and nursing infants readily absorb methylmercury via transplacental transfer and breast milk. Once ingested, methylmercury is absorbed rapidly and efficiently, with over 95% absorbed from the gastrointestinal tract into the bloodstream.[134] Methylmercury binds to cysteine residues of hemoglobin in erythrocytes, and thus over 90% of blood mercury is found in red blood cells.[131] Methylmercury is observed in the blood 15 minutes after ingestion and exhibits peak blood concentrations after three to six hours.[135] Interestingly, of the three cysteine residues methylmercury binds to in hemoglobin, two are in the contact junctions of the α and β chains, which may account for the ability of methylmercury transfer to tissues, as the contact junctions undergo significant conformational changes when oxygen is released from hemoglobin in tissues.[116]

Methylmercury is transferred to many critical organs, including the central nervous system, liver, and kidney.[116] The methylmercury-cysteine complex readily crosses the blood brain barrier through the neutral amino acid carrier by mimicking methionine.[131] The distribution of methylmercury to all body tissues takes 30-40 hours.[128] Once fully distributed, approximately 10% of the body burden is found in the brain and 5% remains in the blood.[116, 128] The rest is distributed in varying amounts to other organs and tissues.

Metabolism occurs throughout the body and follows different mechanisms in different tissues, many of which are not fully known. In the brain, methylmercury is slowly converted to inorganic mercury, a highly potent neurotoxin that cannot pass the blood-brain barrier.[116] The brain is widely accepted as the target organ for mercury toxicity in adults and infants, though infants are more sensitive to the neurotoxic effects. Infants receiving high doses of methylmercury exhibit general brain lesioning, while adults typically exhibit focal lesioning.[116] In particular, lesioning of the anterior portion of the calcarine cortex (impacting peripheral vision and visual processing), the precentral and postcentral gyri (impacting motor control), and loss of cerebellar granule cells are considered the hallmarks of methylmercury poisoning and Minamata Disease.[136-138]

Other demethylation sites exist in different parts of the body as well, including enterohepatic circulation.[131] In the liver, methylmercury forms a complex with reduced glutathione and is secreted into bile. Upon hydrolysis, the methylmercury-cysteine complex is released back into the blood stream. However, a portion of the glutathione complex remains unhydrolyzed and is secreted back into the intestine.[139] Demethylation occurs in other tissues as well, though conversion rates are generally slow.[116]

Methylmercury is not readily excreted, but rather must be converted to inorganic mercury. Demethylation of methylmercury is achieved in many body tissues, but the primary route for excretion is demethylation via intestinal flora.[131] Once methylmercury in the intestine has been converted to inorganic mercury, approximately 90% is excreted in the feces. The remaining 10% is excreted in the urine after renal filtration.[116] The slow metabolism of methylmercury contributes to its slow excretion rate, with most estimates stating that approximately 1% of the total body burden of methylmercury is excreted each day. Additionally, long *in vivo* half-lives have been observed for methylmercury, with estimates ranging from 45 to 70 days.[131]

1.3.4. Current State of Mercury in the U.S.

1.3.4.1. Government Regulations and Advisories

Based on historical incidents of methylmercury poisoning in Japan and Iraq, as well as indications that large, predatory seafood species may contain large amounts of mercury in their flesh, the FDA and the USEPA have published guidelines for seafood consumption by sensitive populations (including pregnant and nursing women, women who may become pregnant and young children). In 2004, the agencies jointly published recommendations for these populations, with three key recommendations:[11]

1. Do not eat shark, swordfish, king mackerel, or tilefish. They contain high levels of mercury.
2. Eat up to 12 ounces (2 average meals) a week of a variety of fish and shellfish that are lower in mercury.
3. Check local advisories about the safety of fish caught by family and friends in local lakes, rivers, and coastal areas.

The goal of this advice is to increase seafood consumption for its health benefits, while minimizing the risk from methylmercury.

In addition to these recommendations, the FDA has regulatory authority over seafood in U.S. commercial markets. In 1984, the FDA established an Action Level of 1000 ppb total mercury in commercial fish.[140] In 2011, the Action Level was challenged by private citizens, seeking to lower it to 500 ppb.[141] In 2013, the FDA responded to the petition and declined to change the Action Level, stating that there was not enough compelling evidence to support lowering the Action Level.[142] Thus, the Action Level has been maintained at 1000 ppb, though there are concerns as to whether this is being adequately enforced in the U.S.[143]

The USEPA has taken a different approach in making recommendations regarding seafood consumption and mercury intake. The USEPA has established a Reference Dose (RfD) for mercury of 0.1 μg/kg body weight-day.[144] This RfD is based upon evidence from large epidemiological studies of developing children in the Seychelles,[122] Faroe Islands,[120] and New Zealand.[145] Because the Faroe Islands studies showed the most significant deficits, the recommendations were based upon those results.[144] In accordance with this RfD, the USEPA has recommended that blood mercury levels stay below 5.8 μg/L.[146] However, umbilical cord blood has a 1.7-fold higher concentration of mercury than maternal blood, and it has been suggested that maternal blood levels be maintained at 3.5 μg/L or less to keep fetal blood levels under 5.8 μg/L.[147] For a person weighing 60 kg (132 lbs), this corresponds to eating no more than 8 ounces of fish with up to 185 ppb per week.[143] Thus, the RfD is much more restrictive than the FDA's Action Level and offers more protection for sensitive populations.

1.3.4.2. Exposure Assessments

Determining mercury exposure levels among seafood consumers is a challenging task that has been approached in many different ways. One recent analysis by Groth ranked seafood species based on their overall contribution to mercury consumption by consumers.[148] In this analysis, mercury concentration was multiplied by total market share to determine the relative mercury contribution of each species. It was found that canned tuna (light plus albacore) was responsible for 31.7% of the mercury consumed in the U.S. Additionally, the report notes that all high mercury species, with the exception of swordfish, are consumed in very low amounts, and thus contribute very little to total mercury consumption.

Recently, the USEPA published a comprehensive report analyzing National Health and Nutrition Examination Survey (NHANES) data from 1999-2010 on blood mercury concentration, seafood consumption, and mercury intake in women of childbearing age.[149] The goal of this analysis was to determine the effectiveness of mercury reduction strategies and seafood risk-communication to the general public. Each analysis period for NHANES covered two years, thus six different two year periods were available for analysis. The factors considered for the USEPA analysis included 24-hour dietary recalls, 30-day frequency of fish consumption surveys, blood mercury levels, and demographical information. To estimate mercury intake from seafood sources, information was gathered from 20 different sources, including government agencies and published research reports from academic sources.[149] Extensive statistical analyses were performed to determine trends within the data.

The overall results indicated that blood mercury levels were significantly higher during the 1999-2000 survey period than they were during the subsequent 10 years, though seafood consumption in the surveyed populations has remained largely unchanged.[149] One of the most striking results is the decrease in women with blood mercury levels above the USEPA RfD of 5.8 μg/L. During the 1999-2000 survey period, 7.13% of women exceeded the RfD, which is 2.86 times higher than the average percentage from 2001-2010. Additionally, there is a marginally significant, negative trend between mercury intake and fish consumed across the six survey periods, indicating that women are starting to choose seafood that is lower in mercury.[149] The USEPA report states that this is a result of improved risk communication and education, though it is worth considering the availability of different species to consumers. During the study period evaluated by the USEPA, aquaculture has increased exponentially and provided many species at low cost.[150] Species like tilapia and pangasius/swai were virtually unknown 15 years ago, but are now the fourth and sixth most commonly consumed seafoods, respectively.[2] Additionally, canned tuna consumption has dropped dramatically over the same time period.[2] The combination of increased consumption of low mercury aquaculture species and decreased consumption of moderate mercury canned tuna may contribute to the observed decrease in blood mercury levels without concomitant changes in fish consumption levels. While the USEPA report monitored the consumed species for mercury calculations, no analysis was conducted to assess the impact of low mercury species becoming readily available at low costs to consumers, which may be a significant variable that contributes to seafood consumption choices.

Finally, upon examination of individual parameters that may impact seafood consumption, significance was found across several demographical characteristics, including age, race, and income level.[149] Higher seafood consumption levels were observed for older women, women of “other races” (including Asian), and higher income levels. When examining blood mercury levels, it was found that although overall seafood consumption did not change during the six survey periods, significant decreases in blood mercury levels were observed. Perhaps unsurprisingly, a correlation was observed between frequency of fish consumption and blood mercury levels. Taken as a whole, these results indicate that there are several prominent predictors of blood mercury levels, but that overall, current risk-communication strategies may be effective in lowering mercury exposure in women of childbearing age.[149]

1.3.5. Analytical Techniques for Measuring Methylmercury

Analytical methods and instrumentation are constantly improving. These improvements often upgrade various parameters, including the accuracy and precision, an expansion of the working range, and a reduction in analysis time. There are two detection methods that are widely used for the detection of mercury in fish tissue: Cold Vapor Atomic Absorption Spectroscopy (CVAAS) and Thermal Decomposition (gold) Amalgamation Atomic Absorption Spectrophotometry (TDA/AAS).[151, 152] Other methods of detection, including Atomic Emission Spectroscopy, Atomic Fluorescence Spectroscopy, Capillary Electrophoresis, Inductively Coupled Plasma-Mass Spectrometry, and Optical Emission Spectroscopy are employed less frequently, but are used for the separation and detection of different chemical forms of mercury.[153]

1.3.5.1. Cold Vapor Atomic Absorption Spectroscopy

CVAAS was developed in the 1960s, with the most commonly used method developed in 1968 by Hatch and Ott, with a lower limit of detection at 1 ppb.[154, 155] CVAAS works off the principles of AAS, while employing a cold vapor extraction methodology to prevent the loss of mercury due to its volatility. In this technique, mercury is reduced to the ground state (Hg^0) in an acidic solution with stannous ions.

Once the resulting mercury vapor equilibrates in the closed reaction vessel, it is moved with air, nitrogen, or argon to the AAS detector and the resulting signal is measured. When samples containing organic mercury are analyzed with this technique, they must first be ionized by an acidic digestion step before reduction to the ground state. Additionally, when interferences are present in the sample, this technique may require extensive purification before mercury isolation is achieved. Despite the lengthy sample preparation with strong acids, the results of CVAAS are remarkably precise and accurate. This technique has been considered the "gold standard" in mercury analysis since its inception, and is still the most popular technique used in research facilities today.[156, 157]

1.3.5.2. Thermal Decomposition Amalgamation/Atomic Absorption Spectrophotometry

In an effort to create more rapid methods of analysis, the Direct Mercury Analyzer (DMA-80, developed by Milestone, Inc.) was introduced in 1999,[158] with the first laboratory usage reported in 2001.[159] The DMA-80 thermally decomposes samples and passes them through a catalyst tube, where interferences are trapped and removed. All mercury species are reduced to elemental mercury and passed to a gold amalgamator, where mercury is selectively separated from the remaining matrix via amalgamation. The amalgamator is then quickly heated to release the mercury vapors, which are measured by AAS at 253.7 nm. The DMA-80 contains two different cells with different path lengths to provide a working range of 0.005 – 1200 ng of mercury.[160, 161]

Butala and co-workers performed validation and application studies to compare the DMA-80 to CVAAS.[162, 163] In these studies, the calibration methodology, instrumental performance over long periods of time, carryover effects between samples, interlaboratory bias, and application to different biological matrices containing mercury (including fish and human hair) were examined. The results obtained from fish samples were compared to the results from CVAAS and were found to exhibit good agreement in almost all cases. The consistency in results between the two methodologies has also been verified in other reports.[151, 164]

The main advantages of using the DMA-80 for analysis are the short analysis times (each sample can be analyzed in less than six minutes) and the need for little or no sample preparation. This instrument has been shown to perform with comparable accuracy and precision to previously established analysis methods, making it an ideal research tool for analyses requiring high throughput and large numbers of samples. It has been widely accepted as a reliable research tool and is accepted for use with USEPA Method 7473.[152]

1.4. Thesis Overview

Based upon the wealth of data surrounding the importance of seafood consumption, the health benefits of long-chain fatty acids, and the neurotoxic effects of methylmercury, the work that follows examines a large variety of finfish species commonly consumed in the U.S. A total of 77 finfish species were collected from 16 commercial seafood vendors in six different regions of the country (Great Lakes, Mid-Atlantic, New England, Northwest, Southeast, and Southwest). The goal of this work is to update the status of fish in commercial markets, as these are the fish that people are most commonly consuming. In an effort to adequately reflect fish in the marketplace, samples were collected directly from commercial vendors. Background data was collected for all samples. Vendors were required to fill out sample cards (Appendix, Figure A.1) so that the origin and size of each species could be monitored. Additionally, photos were requested for positive identification of each species.

Due to the large volume of samples and the lengthy Folch extraction procedure for fatty acids, each species was composited before analysis. Each composite consisted of three fish. Fatty acids were analyzed in duplicate, while mercury was analyzed in triplicate. Chapter two of this thesis summarizes the fatty acid profiles of the samples collected in this study, while chapter three describes details the mercury results obtained during this study. Tracking information, full fatty acid profiles, and mercury measurements for each species are shown in the appendix (Table A.1) and will be posted at www.fish4health.net in the near future.

CHAPTER 2. FATTY ACID PROFILES OF COMMERCIALLY-AVAILABLE FINFISH IN THE U.S.

This manuscript has been submitted to the journal *Lipids* and is written in the style required by the journal.

2.1. Abstract

Seventy seven finfish species (294 composites of three fish) were obtained from commercial seafood vendors in six regions of the U.S. (i.e., Great Lakes, Mid-Atlantic, New England, Northwest, Southeast, and Southwest). Full fatty acid profiles were determined for each species, with the most nutritionally relevant fatty acids presented here. Total EPA plus DHA content ranged from 17 mg/100 g (pangasius/swai) to 5623 mg/100 g (bluefin tuna). Of the top ten most popularly consumed seafoods in the U.S., finfish, including salmon (717 – 1533 mg/100 g), Alaskan pollock (236 mg/100 g), tilapia (76 mg/100 g), channel catfish (44 mg/100 g), Atlantic cod (253 mg/100 g), and pangasius/swai (17 mg/100 g), exhibited a wide concentration range of EPA and DHA. Large differences were also found in farmed species, likely stemming from dietary differences in the farm-fed diet.

2.2. Keywords

Fatty acids, n-3 fatty acids, EPA, DHA, commercial fish, consumption advice.

2.3. Abbreviations

ALA	Alpha-linolenic acid (18:3n-3)
ARA	Arachidonic acid (20:4n-6)
ARS	Agricultural Research Service
DHA	Docosahexaenoic acid (22:6n-3)
DHHS	United States Department of Health and Human Services
DPAn-3	Docosapentaenoic acid (22:5n-3)
EPA	Eicosapentaenoic acid (20:5n-3)
GL	Great Lakes region
GLA	Gamma-linolenic acid (18:3n-6)
LNA	Linoleic acid (18:2n-6)
MA	Mid-Atlantic region
MUFA	Monounsaturated Fatty Acids
NE	New England region
NND	National Nutrient Database
NW	Northwest region
PUFA	Polyunsaturated Fatty Acids
RRF	Relative Retention Factor
SDA	Stearidonic acid (18:4n-3)
SE	Southeast region

SFA	Saturated Fatty Acids
SW	Southwest region
USDA	United States Department of Agriculture

2.4. Introduction

Fish are an important part of the U.S. diet. In 2012, Americans consumed an average of 14.4 pounds of seafood per capita [1]. Fish are the primary dietary source of long-chain omega-3 fatty acids, particularly, eicosapentaenoic acid (EPA, C20:5n-3) and docosahexaenoic acid (DHA, C22:6n-3), which provide health benefits through all life stages [2].

Long-chain omega-3 fatty acids have been shown to be crucial for the healthy development of fetuses and young children, as EPA and DHA are ubiquitous components of cell membranes in the developing brain and photoreceptors [3, 4]. Human and animal studies have shown that the absence of omega-3 fatty acids in infants leads to slower neurological development [5-10] and poorer performance on tests of visual acuity [11-13]. Because fetal and infant nutrition is dependent upon the maternal diet, it is important that women of child-bearing age consume an adequate amount of healthy fatty acids in their diets. The U.S. Department of Agriculture (USDA) and U.S. Department of Health and Human Services (DHHS) recently recommended that adults consume 8-12 ounces of seafood each week, which may provide 250 mg of EPA plus DHA per day [14]. Additionally, the USDA-DHHS emphasize that pregnant and nursing women consume 8-12 ounces of seafood weekly, with the goal of providing their offspring with the necessary EPA plus DHA [14].

Omega-3 fatty acids have also been shown to provide health benefits for seniors. Improved outcomes in heart health have been noted, including reductions in the occurrence of cardiovascular disease [15, 16], heart failure [15, 17], and sudden cardiac death [18, 19]. EPA and DHA may also provide cognitive protection for aging neurons [20, 21]. These fatty acids have even been explored as treatment options for mild cases of Alzheimer's Disease and dementia [3, 4, 22].

Given the myriad of possible health benefits associated with EPA and DHA, it is important that more information is available to consumers on foods containing these healthy fats. While the USDA Agricultural Research Service (USDA-ARS) maintains a National Nutrient Database (USDA-ARS NND), containing 267 listings for seafood items [23], there are less than 50 species of finfish and 25 categories of finfish (e.g., shark). There are far more species readily available to the American consumer, especially considering that different species are preferred or available in different areas of the country. Additionally, there are large differences in fish from different sources and populations. In particular, the fatty acid composition of farmed and wild-captured fish are significantly different [24, 25], due to the fact that the diet of farmed fish is affected by feed amount and composition and can change over time [26]. The objective of this study was to survey the most commonly consumed species in the U.S. to determine fatty acid profiles.

2.5. Materials and Methods

2.5.1. Collection Protocol

Fish were obtained from commercial vendors in six regions of the U.S., including the Great Lakes (GL), Mid-Atlantic (MA), New England (NE), Northwest (NW), Southeast (SE), and Southwest (SW). Three samples of at least 200 g were requested for each species in addition to tracking information (vendor, supplier, wild or farm raised, country/body of water of origin), length, and weight of each fish. Photos were taken by vendors and sent with the samples to help ensure positive identification of each species. From each region, samples of each species were collected during two seasons, 4-12 months apart. In total, 77 species (294 composites of three fish) were collected during this study. The species that were tested along with full tracking details, including the date received, region, and origin of all samples, are available at www.fish4health.net.

Fish species were divided into three categories for collection. The "top ten species" are the most commonly consumed finfish in the U.S., according to the National Marine Fisheries Service [1]. The "other popular species" include fish commonly consumed across the U.S. that are higher in n-3 fatty acids. Finally, to include species that are popular in different parts of the country, experts in each region were consulted in the development of "regionally-popular species" lists. All regions except MA were asked to provide "top ten", "other popular" and "regionally-popular" species. For the MA region, only swordfish and striped bass from the "other popular species" list were requested in addition to the "regionally-popular species".

The "top ten species" included Atlantic salmon (*Salmo salar*), Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), sockeye salmon

(*Oncorhynchus nerka*), Alaskan pollock (*Theragra chalcogramma*), tilapia (family: cichlidae; tribe: tilapiini), channel catfish (*Ictalurus punctatus*), Atlantic cod (*Gadus morhua*), and pangasius/swai (*Pangasius hypophthalmus*). The "other popular species" included striped bass (*Morone saxatilis*), swordfish (*Xiphias gladius*), Alaskan halibut (*Hippoglossus stenolepis*), rainbow trout (*Oncorhynchus mykiss*), monkfish (*Lophius* spp.), red snapper (*Lutjanus campechanus*), grouper (family: *Serranidae*; subfamily: *Epiniphelus*) or red grouper (*Epinephelus morio*), black sea bass (*Centropristis striata*), mahi mahi (*Coryphaena hippurus*), and orange roughy (*Hoplostethus atlanticus*).

"Regionally-popular species" differed by region. GL vendors provided the following species: summer flounder (*Paralichthys dentatus*), bluefin tuna (*Thunnus thynnus*), lake trout (*Salvelinus namaycush*), walleye (*Sander vitreus*), yellow perch (*Perca flavescens*), lake whitefish (*Coregonus clupeaformis*), and rainbow smelt (*Osmerus mordax*). MA vendors provided the following species: striped bass, swordfish, Atlantic croaker (*Micropogonias undulatus*), bluefish (*Pomatomus saltatrix*), spot (*Leiostomus xanthurus*), summer flounder, white perch (*Morone americana*), scup (*Stenotomus chrysops*), spiny dogfish (*Squalus acanthias*), and skate (family: *Rajidae*). NE vendors provided the following species: yellowtail flounder (*Limanda ferruginea*), winter flounder (*Pseudopleuronectes americanus*), Atlantic pollock (*Pollachius pollachius*), yellowfin tuna (*Thunnus albacares*), haddock (*Melanogrammus aeglefinus*), grey sole (*Glyptocephalus cynoglossus*), silver hake (*Merluccius bilinearis*), tilefish – north Atlantic population (*Lopholatilus chamaeleonticeps*), American plaice (*Hippoglossoides platessoides*), and American shad (*Alosa sapidissima*). NW vendors provided the following species: lingcod (*Ophiodon elongates*), sablefish (*Anoplopona* *fimbria*), Pacific cod (*Gadus macrocephalus*), Pacific Dover sole (*Microstomus pacificus*), English sole (*Parophrys vetulus*), petrale sole (*Eopsetta jordani*), rex sole (*Glyptocephalus zachirus*), white sturgeon (*Acipenser transmontanus*), green sturgeon (*Acipenser medirostris*), albacore tuna (*Thunnus alalunga*), brown rockfish (*Sebastes auriculatus*), widow rockfish (*Sebastes entomelas*), Pacific Ocean perch (*Sebastes alutus*), Pacific whiting (*Merluccius productus*), and Chilean sea bass (*Dissostichus eleginoides*). SE vendors provided the following species: king mackerel (*Scomeromorus cavalla*), tilefish – Gulf of Mexico population, Spanish mackerel (*Scomberomorus maculatus*), Atlantic croaker, greater amberjack (*Seriola dumerili*), striped mullet (*Mugil cephalus*), yellowfin tuna, gag grouper (*Mycteroperca microlepis*), yellowedge grouper (*Hyporthodus flavolimbatus*), yellowtail snapper (*Ocyurus chrysurus*), vermilion snapper (*Rhomboplites aurorubens*), Florida pompano (*Trachinotus carolinus*), spotted seatrout (*Cynoscion nebulosus*), Gulf flounder (*Paralichthys albigutta*), and southern flounder (*Paralichthys lethostigma*). SW vendors provided the following species: Pacific Dover sole, petrale sole, common thresher shark (*Alopias vulpinus*), white sea bass (*Atractoscion nobilis*), California halibut (*Paralichthys californicus*), yellowtail amberjack (*Seriola lalandi*), sablefish, albacore tuna, wahoo (*Acanthocybium solandri*), lingcod, and Chilean sea bass.

2.5.2. Sample Preparation

Samples were packed on ice and sent via overnight shipping to Purdue University, where testing was completed. Upon arrival, the temperature of each sample was measured to ensure that it was 7 °C or lower. All fish were immediately filleted, with skin and pin bones removed. Homogeneous composites of the three fillets of each species were created by grinding in a food processor (Robot-Coupe R2 Ultra, Robot Coupe USA, Inc., Ridgeland, MS, USA). Samples were packed in sampling bags (Fisher Scientific, Pittsburgh, PA, USA) and frozen at –20 °C until analysis.

2.5.3. Fatty Acid Determination

2.5.3.1. Chemicals

Chloroform (ACS grade), methanol (ChromAR grade), and anhydrous sodium sulfate (ACS grade) were purchased from Macron Fine Chemicals (Center Valley, PA, USA). Sodium chloride (ACS grade), sodium hydroxide (ACS grade), and isooctane (pesticide grade) were purchased from Fisher Scientific (Waltham, MA, USA). Butylated hydroxytoluene (BHT) was purchased from United States Biochemical Corp. (Cleveland, OH, USA). BF_3-methanol (10% w/w) and PUFA No. 3 menhaden oil were purchased from Sigma-Aldrich (St. Louis, MO, USA). Methyl tricosanoate (>99% pure) and GLC Reference Standard 462 were purchased from Nu-Chek Prep, Inc. (Elysian, MN, USA).

2.5.3.2. Extraction

Each composited fish sample was analyzed in duplicate. Extraction of fat from fish tissue was achieved using a modified Folch method [27, 28]. Raw fish tissue (5 g), 10 mg methyl tricosanoate (as an internal standard), and 100 mL chloroform-methanol solution (2:1 v/v) were homogenized with a hand-held homogenizer (Tissue Tearor Model 985370-14, BioSpec Products, Inc., Bartlesville, OK, USA). The slurry was placed on a shaker at 200 rpm for 2 h (IKA KS 260 Basic, IKA Works, Inc., Wilmington, NC, USA). The resulting slurry was filtered, with the filtrate placed in a separatory funnel and rinsed with 30 mL potassium chloride solution (0.88% w/v). The organic layer was removed and filtered through anhydrous sodium sulfate. Solvent was removed via a TurboVap II Concentration Workstation (Zymark Corp., Westborough, MA, USA) at 40 ºC. The concentrated samples were transferred to test tubes and further concentrated with a Meyer N-Evap (Organomation Association Inc., South Berlin, MA, USA). The concentrated fatty acids were placed in a desiccator overnight to remove residual solvent.

2.5.3.3. Derivatization

The extracted fatty acids were derivatized to methyl esters following a modified AOAC Official Method, 991.39 [29]. Methanolic sodium hydroxide (2 mL, 0.5 N) was added to the extracted fatty acids and heated for 10 min at 105 ºC on a heating block (VWR International, Radnor, PA, USA). Upon cooling, BF_3-methanol (3 mL) was added and again heated for 30 min at 105 ºC. Isooctane (1 mL) was added to the cooled mixture and vortexed for 30 s. A saturated solution of sodium chloride (4 mL) was added and vortexed for 30 s before centrifuging at 1500 rpm for 5 min (international clinical centrifuge model CL, International Equipment Co., Needham Heights, MA, USA). The organic layer was removed and set aside. To the aqueous layer, BHT-methanol solution (50 µL, 10 mg/mL) and isooctane (1 mL) were added. The mixture was again vortexed and centrifuged. The organic layer was removed and combined with the first extract. An aliquot (1 mL) was transferred to a GC vial and blanketed with nitrogen.

2.5.3.4. GC-FID Determination of Fatty Acids

The derivatized fatty acid methyl esters were analyzed by gas chromatography with a flame ionization detector and split/splitless injector (GC/FID, Varian 3900 GC, CP-8400 auto sampler, CP-8410 auto injector, Varian Analytical Instruments, Walnut Creek, CA, USA). A CP-52CB wax capillary column was used for analysis (CP 8843, 30 m x 0.32 mm I.D., DF-25 coating thickness 0.25 µm; Agilent Tecnologies, Inc., Santa Clara, CA, USA). Operating conditions were: injection port temperature, 250 °C; detector temperature, 300 °C; oven programmed from 170 °C for 4 min to final hold temperature of 240 °C for 4 min, with an increase of 3 °C/min; helium carrier gas, 2.5 mL/min (99.995% pure, Indiana Oxygen Co., Indianapolis, IN, USA). The FID operated with the following flow rates: helium, 25 mL/min; hydrogen, 30 mL/min (99.8% pure, Inweld Corp., Indianapolis, IN, USA); compressed air, 300 mL/min (commercial grade, Specialty Gases of America, Toledo, OH, USA).

Peaks were identified using two known standards (PUFA No. 3 and GLC 462). These standards were run monthly to verify the method of peak identification. Blanks were run for all new solvents and other chemicals to verify purity before using them for analysis of tissue samples. Additionally, duplicate samples displaying differences greater than 10% in multiple fatty acids were repeated. Applying this criterion, 13.4% of all samples needed to be retested.

2.5.3.5. Calculations/Quantitative Analysis

Quantitation of fatty acids was achieved using AOAC Official Method 991.39 [29] and the work of Tvrzická et al. [30]. A total of 31 fatty acids were measured, with a limit of quantification (LOQ) of 1 mg/100 g. The equation $C_{FA} = (m_{IS} * A_{FA} * RRF_{FA}) / (1.04 * m_{fish} * A_{IS})$ was used to quantify all measured fatty acids [29], where C_{FA} is the concentration of the fatty acid in mg/g, m_{IS} is the weight of the internal standard, A_{FA} is the fatty acid peak area in the GC spectrum, RRF_{FA} is the relative retention factor for each fatty acid [30], *1.04* is the correlation factor between fatty acids and fatty acid methyl esters, m_{fish} is the weight of the fish tissue, and A_{IS} is the internal standard peak area in the GC spectrum. The RRF value accounts for the effective carbon number and is calculated according to previously published methods [30]. The following fatty acids (with their RRF values) were measured: lauric acid, C12:0 (RRF = 1.114); myristic acid, C14:0 (RRF = 1.080); myristoleic acid, C14:1n-5 (RRF = 1.071); palmitic acid, C16:0 (RRF = 1.055); palmitoleic acid, C16:1n-7 (RRF = 1.047); hexadecadienoic acid, C16:2n-4 (RRF = 1.039); hexadecatrienoic acid, C16:3n-4 (RRF = 1.031); stearic acid, C18:0 (RRF = 1.035); vaccenic acid, C18:1n-7 (RRF = 1.028); oleic acid, C18:1n-9 (RRF = 1.028); linoleic acid (LNA), C18:2n-6 (RRF = 1.021); α-linolenic acid (ALA), C18:3n-3 (RRF = 1.014); octadecatetraenoic acid, C18:3n4 (RRF = 1.014); γ-linolenic acid (GLA), C18:3n-6 (RRF = 1.014); stearidonic acid (SDA), C18:4n-3 (RRF = 1.007); arachidic acid, C20:0 (RRF = 1.019); gondolic acid, C20:1n-9 (RRF = 1.012); eicosadienoic acid, C20:2n-6 (RRF = 1.006); eicosatrienoic acid, C20:3n-3 (RRF = 1.000); homo-γ-linolenic acid, C20:3n-6 (RRF = 1.000); eicosatetraenoic acid, C20:4n-3 (RRF = 0.994); arachidonic acid (ARA), C20:4n-6 (RRF = 0.994); eicosapentaenoic acid (EPA), C20:5n-3 (RRF = 0.987); behenic acid, C22:0 (RRF = 1.006); erucic acid, C22:1n-9 (RRF = 1.000); docosadienoic acid; C22:2n-6 (RRF = 0.994); adrenic acid, C22:4n-6 (RRF = 0.983);

docosapentaenoic acid (DPAn-3), C22:5n-3 (RRF = 0.977); docosahexaenoic acid (DHA), C22:6n-3 (RRF = 0.971); tricosanoic acid, C23:0 (RRF = 1.000); lignoceric acid, C24:0 (RRF = 0.995); and nervonic acid, C24:1n-9 (RRF = 0.990).

2.6. Results

Full fatty acid profiles were determined for all species obtained in this study. The most nutritionally relevant fatty acid concentrations are presented in Tables 2.1-2.3; full fatty acid profiles are available at www.fish4health.net. Fatty acids were present in a wide range of concentrations, with some wild species and a few farmed species (salmon and sturgeon) showing higher concentrations of most fatty acids.

Total n-3 fatty acid content ranged from 26 mg/100 g (pangasius/swai) to 7221 mg/100 g (bluefin tuna), with Chilean sea bass (3011 mg/100 g), albacore tuna (2631 mg/100 g), Atlantic salmon (2544 mg/100 g), and farmed Chinook salmon (2179 mg/100 g) having the next highest total n-3 content. Total n-6 content ranged from 11 mg/100 g (Alaskan pollock) to 2530 mg/100 g (Atlantic salmon). Interestingly, the six species with the highest n-6 content were all farmed, including Atlantic salmon (2530 mg/100 g), green sturgeon (1770 mg/100 g), white sturgeon (1377 mg/100 g), channel catfish (1201 mg/100 g), Chinook salmon (1173 mg/100 g), and striped bass (914 mg/100 g).

Total SFA ranged from 81 mg/100 g (gulf flounder) to 7111 mg/100 g (bluefin tuna), with four of the nine highest SFA containing species being farmed (Chinook salmon, green sturgeon, Atlantic salmon, and white sturgeon). Total MUFA ranged from 34 mg/100 g (gulf flounder) to 15545 mg/100 g (Chilean sea bass), with the same farmed species plus farmed channel catfish accounting for five of the eight highest MUFA species. Finally, total PUFA content ranged from 108 mg/100 g (gulf flounder) to 8358 mg/100 g (bluefin tuna), with farmed salmon and sturgeon species again having some of the highest total PUFA concentrations.

Figures 2.1 and 2.2 show the average amount of EPA plus DHA obtained from consuming 8 ounces (227 g, uncooked weight) of each species, and compare the results of this study to the USDA-ARS NND [23]. In general, the results of this study compared well with the database. As EPA and DHA are considered the most important fatty acids for health, the USDA-DHHS Dietary Guidelines for Americans, 2010, recommends consuming 8-12 ounces of fish per week [14]. This level of consumption may provide an average of 250 mg EPA plus DHA per day [14], or 1750 mg per week, for a healthy diet. Based on the results of this study, consuming 227 g of albacore tuna, Atlantic salmon, bluefin tuna, Chilean sea bass, Chinook salmon (farmed or wild), green sturgeon, lake trout, farmed rainbow trout, sablefish, spiny dogfish, spot, or farmed white sturgeon will, on average, provide the recommended amount of EPA plus DHA each week.

2.7. Discussion

When examining the fatty acid concentrations of fish in this study, large standard deviations were observed for all species, due to fish being harvested or produced with various feed formulations from different locations and at different times of the year [31, 32]. Large standard deviations have also been observed in other studies [33, 34], illustrating the challenges in creating accurate nutrient databases. Thus, studies like this one are important to continually update and expand available information, while reflecting the current status of commercially-available fish.

In an effort to bolster the USDA-ARS NND [23], the samples collected in this study were tracked (i.e., for harvest location and size parameters), and they were collected from different regions of the U.S. during different seasons. In addition, species within the same genus or family were differentiated. For example, Chilean sea bass had higher concentrations of all fatty acids than black or white sea bass. These differences are quite distinct when looking at the EPA plus DHA content of each sea bass. Chilean sea bass (5511 mg per 227 g) contained far more EPA plus DHA than black sea bass (631 mg per 227 g) or white sea bass (417 mg per 227 g). However, the USDA-ARS NND only lists "sea bass, mixed species" and shows EPA plus DHA content at 1349 mg per 227 g [23]. Sea bass, in particular, is a highly substituted species; several vendors substituted Chilean sea bass for black sea bass during this study. Several other fish categories, including flatfish, grouper, perch, rockfish, shark, snapper, and sturgeon, also exhibit differences between species and would benefit from differentiation as separate species.

Fatty acid profiles in fish are dependent upon a number of factors, with dietary nutrients being the easiest factor to manipulate [35]. For wild-caught species, the diet is determined by changes in environmental conditions, while the composition of farmed species is dependent upon amount and composition of feed [26]. To control costs, diets high in inexpensive and readily available fatty acids, like SFA, MUFA, and n-6 obtained from plant or animal sources, are often used in aquaculture [35, 36]. Accordingly, these fatty acids were measured in higher concentrations in many farmed species than they were in wild species analyzed in this study. In contrast, total n-3 content was not as high in farmed species, with the exception of Atlantic and Chinook salmon. Diets high in n-3 fatty acids are more expensive, as they are derived from fish oils [35, 36], and thus are incorporated into the diet later in the lifetime of farmed fish [37]. Because of these differences and the ability of farmers to continually modify the diet, constantly monitoring fatty acids – particularly EPA, DHA, and n-3 content – in farmed species is necessary to provide consumers with current and accurate information.

Figure 2.2 illustrates how farmed species in this study compare to those in the USDA-ARS NND [23]. Most species compared well, though Chinook salmon and sturgeon showed differences. The EPA plus DHA content of farmed (1533 mg/100 g) and wild (1106 mg/100 g) Chinook salmon in this study were found to be quite different and did not match the USDA-ARS NND (1952 mg/100 g) [23]. Sturgeon (farmed green: 1067 mg/100 g, farmed white: 939 mg/100 g, wild-caught white: 667 mg/100 g, and mixed species (USDA-ARS NND [23]): 287 mg/100 g) exhibited even larger differences. The differences between farmed and wild species mainly stem from dietary differences between aquaculture and wild-caught fish, though other factors, including water quality, activity levels, and overall health may also impact the fatty acid profiles.

This study gives a broad overview of the many commercially-available finfish species in the U.S. The results of this study are comparable to other reports, while providing more specificity within certain species (i.e., sea bass) and confirming large differences in fatty acid content within and between species. Farmed species had higher concentrations of SFA, MUFA, and n-6 fatty acids than wild species. Additionally, farmed species showed vast differences in n-3 content. These differences stem from changes in the diet by fish farmers and necessitate constant monitoring of fatty acids in farmed species. Finally, EPA plus DHA content was measured in all species to illustrate the amount of these fatty acids provided by each species. The results of this study provide a current snapshot of the fatty acid content of commercially-available finfish. Such studies should be continually performed to monitor and expand the available information.

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2.9. Conflicts of Interest

The authors declare no conflicts of interest.

2.10. References

1. National Marine Fisheries Service (accessed Mar. 2014) Fisheries of the United States 2012: Current Fishery Statistics. http://www.st.nmfs.noaa.gov/commercial-fisheries/fus/fus12/index

2. Swanson D, Block R, Mousa SA (2012) Omega-3 fatty acids EPA and DHA: health benefits throughout life. Adv Nutr 3:1-7

3. Luchtman DW, Song C (2013) Cognitive enhancement by omega-3 fatty acids from childhood to old age: findings from animal and clinical studies. Neuropharmacology 64:550-565

4. Oehlenschlager J (2012) Seafood: nutritional benefits and risk aspects. Int J Vitam Nutr Res 82:168-176

5. Fedorova I, Hussein N, Di Martino C, Moriguchi T, Hoshiba J, Majchrzak S, Salem Jr. N (2007) An n-3 fatty acid deficient diet affects mouse spatial learning in the Barnes circular maze. Prostaglandins, Leukotrienes Essent Fatty Acids 77:269-277

6. Chung WL, Chen JJ, Su HM (2008) Fish oil supplementation of control and n-3 fatty acid-deficient male rats enhances reference and working memory performance and increases brain regional docosahexaenoic acid levels. J Nutr 138:1165-1171

7. Lim SY, Hoshiba J, Salem Jr. N (2005) An extraordinary degree of structural specificity is required in neural phospholipids for optimal brain function: n-6 docosapentaenoic acid substitution for docosahexaenoic acid leads to a loss in spatial task performance. J Neurochem 95:848-857

8. Lundqvist-Persson C, Lau G, Nordin P, Strandvik B, Sabel KG (2010) Early behaviour and development in breast-fed premature infants are influenced by omega-6 and omega-3 fatty acid status. Early Human Dev 86:407-412

9. Escolano-Margarit MV, Ramos R, Beyer J, Csabi G, Parrilla-Roure M, Cruz F, Perez-Garcia M, Hadders-Algra M, Gil A, Decsi T, Koletzko BV, Campoy C (2011) Prenatal DHA status and neurological outcome in children at age 5.5 years are positively associated. J Nutr 141:1216-1223

10. Jensen CL, Voigt RG, Llorente AM, Peters Su, Prager TC, Zou YL, Rozelle JC, Turcich MR, Fraley JK, Anderson RE, Heird WC (2010) Effects of early maternal docosahexaenoic acid intake on neuropsychological status and visual acuity at five years of age of breast-fed term infants. J Pediatr 157:900-905

11. Birch EE, Hoffman DR, Uauy R, Birch DG, Prestidge C (1998) Visual acuity and the essentiality of docosahexaenoic acid and arachidonic acid in the diet of term infants. Pediatr Res 44:201-209

12. Innis SM, Friesen RW (2008) Essential n-3 fatty acids in pregnant women and early visual acuity maturation in term infants. Am J Clin Nutr 87:548-557

13. Birch EE, Carlson SE, Hoffman DR, Fitzgerald-Gustafson KM, Fu VLN, Drover JR, Castaneda YS, Minns L, Wheaton DKH, Mundy D, Marunycz J, Diersen-Schade DA (2010) The DIAMOND (DHA Intake And Measurement Of Neural Development) study: a double-masked, randomized controlled clinical trial of the maturation of infant visual acuity as a function of the dietary level of docosahexaenoic acid. Am J Clin Nutr 91:848-859

14. United States Department of Agriculture and United States Department of Health and Human Services (accessed Mar. 2014) Dietary guidelines for Americans 2010. http://www.cnpp.usda.gov/DGAs2010-DGACReport.htm

15. Yamagishi K, Iso H, Date C, Fukui M, Wakai K, Kikuchi S, Inaba Y, Tanabe N, Tamakoshi A (2008) Fish, ω-3 polyunsaturated fatty acids, and mortality from cardiovascular diseases in a nationwide community-based cohort of Japanese men and women: the JACC (Japan Collaborative Cohort Study for Evaluation of Cancer Risk) study. J Am Coll Cardiol 52:988-996

16. Lavie, C. J., R. V. Milani, M. R. Mehra, and H. O. Ventura. 2009. Omega-3 Polyunsaturated Fatty Acids and Cardiovascular Diseases. *Journal of the American College of Cardiology* **54**: 585-594

17. Djoussé L, Akinkuolie AO, Wu JHY, Ding EL, Gaziano JM (2012) Fish consumption, omega-3 fatty acids and risk of heart failure: a meta-analysis. Clin Nutr 31:846-853

18. Chattipakorn N, Settakorn J, Petsophonsakul P, Suwannahoi P, Mahakranukrauh P, Srichairatanakool S, Chattipakorn SC (2009) Cardiac mortality is associated with low levels of omega-3 and omega-6 fatty acids in the heart of cadavers with a history of coronary heart disease. Nutr Res 29:696-704

19. Albert CM, Campos H, Stampfer MJ, Ridker PM, Manson JE, Willett WC, Ma J (2002) Blood levels of long-chain n-3 fatty acids and the risk of sudden death. N Engl J Med 346:1113-1118

20. Tan ZS, Harris WS, Beiser AS, Au R, Himali JJ, Debette S, Pikula A, DeCarli C, Wolf PA, Vasan RS, Robins SJ, Seshadri S (2012) Red blood cell omega-3 fatty acid levels and markers of accelerated brain aging. Neurology 78:658-664

21. Dyall SC, Michael-Titus AT (2008) Neurological benefits of omega-3 fatty acids. Neuromolecular Med 10:219-235

22. Haag M (2003) Essential fatty acids and the brain. Can J Psychiatry 48:195-203

23. United States Department of Agriculture (accessed Mar 2014) National nutrient database. http://ndb.nal.usda.gov/

24. Hossain MA (2011) Fish as source of n-3 polyunsaturated fatty acids (PUFAs), which one is better - farmed or wild? Adv J Food Sci Tech 3:455-466

25. Kaya Y, Erdem ME (2009) Seasonal comparison of wild and farmed brown trout (*Salmo trutta forma fario* L., 1758): crude lipid, gonadosomatic index and fatty acids. Int J Food Sci Nutr 60:413-423

26. Farrell AP, Friesen EN, Higgs DA, Ikonomou MG (2010) Toward improved public confidence in farmed fish quality: a Canadian perspective on the consequences of diet selection. J World Aquacult Soc 41:207-224

27. Folch J, Lees M, Sloane Stanley GH (1957) A simple method for the isolation and purification of total lipids from animal tissues. J Biol Chem 226:497-509

28. Gallina Toschi T, Bendini A, Ricci A, Lercker G (2003) Pressurized solvent extraction of total lipids in poultry meat. Food Chem 83:551-555

29. AOAC (2007) AOAC official method 991.39, fatty acids in encapsulated fish oils.

30. Tvrzická E, Vecka M, Staňková B, Žák A (2002) Analysis of fatty acids in plasma lipoproteins by gas chromatography–flame ionization detection quantitative aspects. Anal Chim Acta 465:337-350

31. Jobling M, Bendiksen E (2003) Dietary lipids and temperature interact to influence tissue fatty acid compositions of Atlantic salmon, *Salmo salar L., parr*. Aquacult Res 34:1423-1441

32. Gallagher M, McLeod S, Rulifson R (1989) Seasonal variations in fatty acids of striped bass *Morone saxatilis*. J World Aquacult Soc 20:38-45

33. Louly A, Gaydou E, Kebir M (2011) Muscle lipids and fatty acid profiles of three edible fish from the Mauritanian coast: *Epinephelus aeneus, Cephalopholis taeniops* and *Serranus scriba*. Food Chem 124:24-28

34. Strobel C, Jahreis G, Kuhnt K (2012) Survey of n-3 and n-6 polyunsaturated fatty acids in fish and fish products. Lipids in Health Dis 11:144-153

35. Hardy RW, Lee CS (2010) Aquaculture feed and seafood quality. Bull Fish Res Agen 31:43-50

36. Babalola T, Apata D, Omostosho J, Adebayo M (2011) Differential effects of dietary lipids on growth performance, digestibility, fatty acid composition and histology of African catfish (*Heterobranchus longifilis*) fingerlings. Food Nutr Sci 2:11-21

37. Subhadra B, Lochmann R, Rawles S, Chen RG (2006) Effect of dietary lipid source on the growth, tissue composition and hematological parameters of largemouth bass (*Micropterus salmoides*). Aquacult 255:210-222

2.11. Tables and Figures

Table 2.1. Total n-3, n-6, SFA, MUFA, and PUFA in commercial U.S. finfish (mg/100 g).

Species	n[a]	n-3[b]	n-6[c]	SFA[d]	MUFA[e]	PUFA[f]
Amberjack, Greater	2	148 ± 16	43 ± 10	139 ± 16	52 ± 11	193 ± 14
Amberjack, Yellowtail	2	714 ± 72	75 ± 2.0	671 ± 44	576 ± 39	806 ± 75
Bass, Striped (F)[g]	5	699 ± 184	914 ± 179	1450 ± 390	2524 ± 610	1653 ± 299
Bass, Striped (W)[g]	5	610 ± 244	85 ± 33	567 ± 244	576 ± 290	746 ± 312
Bluefish	3	896 ± 549	159 ± 113	1242 ± 866	1087 ± 751	1088 ± 684
Catfish, Channel (F)	11	130 ± 24	1201 ± 262	1717 ± 394	3649 ± 882	1335 ± 283
Cod, Atlantic (F)	1	265 ± 15	22 ± 0.8	127 ± 8.6	84 ± 4.8	287 ± 15
Cod, Atlantic (W)	8	254 ± 40	16 ± 5.1	120 ± 16	69 ± 17	271 ± 43
Cod, Lingcod	4	333 ± 59	30 ± 9.5	221 ± 61	229 ± 111	370 ± 71
Cod, Pacific	2	205 ± 38	18 ± 3.5	99 ± 19	56 ± 14	223 ± 41
Cod, Sablefish	4	1571 ± 1016	291 ± 52	3319 ± 614	7363 ± 979	1959 ± 1087
Croaker, Atlantic	5	675 ± 382	142 ± 61	1382 ± 1016	1330 ± 1033	837 ± 458
Flatfish, American Plaice	2	351 ± 114	74 ± 31	518 ± 321	782 ± 697	435 ± 152
Flatfish, English Sole	2	303 ± 83	39 ± 2.8	230 ± 83	247 ± 85	351 ± 91
Flatfish, Grey Sole	2	158 ± 15	45 ± 3.0	109 ± 20	59 ± 18	203 ± 18
Flatfish, Gulf Flounder	2	74 ± 14	34 ± 2.9	81 ± 15	34 ± 13	108 ± 17
Flatfish, Pacific Dover Sole	4	187 ± 27	38 ± 11	134 ± 26	99 ± 16	229 ± 36
Flatfish, Petrale Sole	4	327 ± 29	25 ± 2.1	226 ± 20	225 ± 44	360 ± 32
Flatfish, Rex Sole	2	213 ± 25	33 ± 2.3	140 ± 22	87 ± 20	249 ± 28
Flatfish, Southern Flounder	1	98 ± 13	39 ± 4.1	96 ± 14	45 ± 13	138 ± 18
Flatfish, Summer Flounder	5	217 ± 57	28 ± 11	170 ± 61	106 ± 74	248 ± 68
Flatfish, Winter Flounder	1	467 ± 95	67 ± 6.1	252 ± 11	237 ± 16	541 ± 102
Flatfish, Yellowtail Flounder	2	280 ± 29	25 ± 8.2	134 ± 18	105 ± 7.6	309 ± 41
Grouper (unspecified)	3	259 ± 105	62 ± 26	324 ± 156	302 ± 202	326 ± 134
Grouper, Gag	2	129 ± 7.3	42 ± 5.8	109 ± 5.2	63 ± 4.1	173 ± 4.1
Grouper, Red	4	118 ± 39	58 ± 14	175 ± 26	104 ± 18	178 ± 28
Grouper, Yellowedge	1	147 ± 4.0	31 ± 1.3	116 ± 3.8	73 ± 9.0	178 ± 5.3
Haddock	4	192 ± 24	20 ± 3.5	102 ± 15	52 ± 13	212 ± 22
Hake, Silver	2	224 ± 18	12 ± 0.5	117 ± 8.2	68 ± 21	236 ± 19
Halibut, Alaskan	10	299 ± 120	39 ± 40	255 ± 334	415 ± 834	345 ± 168
Halibut, California	2	187 ± 64	23 ± 1.2	123 ± 31	63 ± 22	211 ± 65
Mackerel, King	1	259 ± 37	74 ± 11	454 ± 57	300 ± 12	336 ± 48
Mackerel, Spanish	2	633 ± 172	131 ± 18	1241 ± 177	1079 ± 88	776 ± 196
Mahi Mahi	11	166 ± 50	33 ± 6.5	146 ± 60	96 ± 47	203 ± 55
Monkfish	9	113 ± 31	17 ± 4.3	87 ± 8.4	67 ± 12	130 ± 35
Mullet, Striped	2	707 ± 652	143 ± 91	812 ± 793	386 ± 395	905 ± 801
Pangasius/Swai (F)	8	26 ± 8.9	142 ± 57	446 ± 199	411 ± 203	169 ± 64
Perch, Pacific Ocean	2	638 ± 391	72 ± 21	657 ± 307	861 ± 160	743 ± 433
Perch, White	2	1025 ± 40	458 ± 28	1239 ± 76	2173 ± 128	1530 ± 66
Perch, Yellow	2	175 ± 19	57 ± 6.2	157 ± 20	110 ± 23	236 ± 28
Pollock, Alaskan	7	249 ± 44	11 ± 4.3	127 ± 27	71 ± 19	260 ± 47
Pollock, Atlantic	4	357 ± 87	25 ± 7.6	161 ± 37	130 ± 58	381 ± 94
Pompano, Florida	2	925 ± 18	393 ± 70	4444 ± 834	3538 ± 689	1361 ± 91

Table 2.1. (cont.)

Species	n[a]	n-3[b]	n-6[c]	SFA[d]	MUFA[e]	PUFA[f]
Rockfish, Brown	2	396 ± 62	40 ± 2.6	312 ± 26	366 ± 106	444 ± 62
Rockfish, Widow	2	376 ± 66	31 ± 11	317 ± 135	262 ± 154	416 ± 83
Roughy, Orange	5	200 ± 65	190 ± 211	135 ± 33	2479 ± 656	422 ± 236
Salmon, Atlantic (F)	11	2544 ± 988	2530 ± 1508	2983 ± 864	5290 ± 1620	5212 ± 1834
Salmon, Chinook (F)	2	2179 ± 433	1173 ± 406	3730 ± 705	6682 ± 682	3485 ± 139
Salmon, Chinook (W)	5	1525 ± 269	140 ± 45	1908 ± 293	2649 ± 497	1738 ± 316
Salmon, Coho	7	894 ± 308	66 ± 29	687 ± 290	757 ± 348	979 ± 342
Salmon, Sockeye	6	934 ± 248	98 ± 38	835 ± 304	1120 ± 484	1052 ± 291
Scup	2	450 ± 172	100 ± 52	594 ± 434	577 ± 512	561 ± 232
Sea Bass, Black	3	320 ± 63	48 ± 11	297 ± 114	284 ± 154	373 ± 74
Sea Bass, Chilean	3	3011 ± 1762	704 ± 362	5403 ± 2307	15545 ± 4443	3798 ± 2130
Sea Bass, White	2	195 ± 37	24 ± 2.3	137 ± 40	65 ± 30	219 ± 39
Seatrout, Spotted	1	804 ± 14	294 ± 5.9	1214 ± 23	1072 ± 29	1161 ± 21
Shad, American	1	726 ± 21	62 ± 1.4	659 ± 14	856 ± 31	801 ± 22
Shark, Common Thresher	1	218 ± 3.1	42 ± 2.4	165 ± 3.3	89 ± 6.8	260 ± 5.5
Shark, Spiny Dogfish	2	1650 ± 1001	302 ± 138	1193 ± 681	1770 ± 1003	1971 ± 1151
Skate	2	197 ± 13	30 ± 2.5	143 ± 12	71 ± 5.3	227 ± 15
Smelt, Rainbow	2	632 ± 85	196 ± 25	453 ± 52	428 ± 38	838 ± 112
Snapper, Red	7	281 ± 133	43 ± 16	252 ± 125	181 ± 135	328 ± 140
Snapper, Vermilion	2	259 ± 70	43 ± 13	247 ± 97	106 ± 40	305 ± 85
Snapper, Yellowtail	3	288 ± 160	54 ± 23	322 ± 208	159 ± 121	348 ± 188
Spot	2	1294 ± 615	320 ± 136	3813 ± 1829	3566 ± 1568	1652 ± 780
Sturgeon, Green (F)	1	1428 ± 100	1770 ± 147	3043 ± 266	5202 ± 441	3295 ± 259
Sturgeon, White (F)	1	1277 ± 22	1377 ± 38	2695 ± 49	4300 ± 71	2743 ± 61
Sturgeon, White (W)	1	1129 ± 38	542 ± 15	1542 ± 68	2616 ± 41	1780 ± 56
Swordfish	12	897 ± 566	155 ± 88	1486 ± 854	2902 ± 1865	1096 ± 654
Tilapia (F)	11	125 ± 40	370 ± 166	744 ± 326	764 ± 359	498 ± 200
Tilefish, (Mexico)	1	164 ± 4.0	24 ± 0.6	103 ± 0.5	48 ± 0.8	191 ± 4.8
Tilefish, (North)	1	151 ± 6.2	27 ± 1.9	115 ± 6.7	82 ± 6.5	178 ± 8.0
Trout, Lake	2	1216 ± 558	409 ± 163	1157 ± 366	1787 ± 515	1662 ± 748
Trout, Rainbow (F)	9	1031 ± 370	598 ± 390	1422 ± 492	1716 ± 736	1676 ± 445
Trout, Rainbow (W)	1	414 ± 17	665 ± 37	1140 ± 69	1454 ± 84	1096 ± 55
Tuna, Albacore	3	2631 ± 1765	228 ± 143	2144 ± 1316	1747 ± 1165	2894 ± 1928
Tuna, Bluefin	1	7221 ± 110	888 ± 8.9	7111 ± 96	8758 ± 121	8358 ± 126
Tuna, Yellowfin	6	174 ± 125	34 ± 15	198 ± 124	131 ± 105	212 ± 140
Wahoo	2	440 ± 214	63 ± 35	597 ± 359	474 ± 352	516 ± 262
Walleye	2	401 ± 278	131 ± 107	303 ± 218	461 ± 448	545 ± 398
Whitefish, Lake	6	1025 ± 250	341 ± 62	892 ± 174	1426 ± 316	1412 ± 321
Whiting, Pacific	2	432 ± 51	32 ± 4.9	344 ± 22	307 ± 33	478 ± 55

[a] number of composite samples; each composite contains three fish.
[b] total of all n-3 fatty acids, including 18:3n-3, 18:4n-3, 20:3n-3, 20:4n-3, 20:5n-3, 22:5n-3, and 22:6n-3.
[c] total of all n-6 fatty acids, including 18:2n-6, 18:3n-6, 20:2n-6, 20:3n-6, 20:4n-6, 22:2n-6, and 22:4n-6.
[d] total of all SFA, including 12:0, 14:0, 16:0, 18:0, 20:0, 22:0, and 24:0.
[e] total of all MUFA, including 14:1n-5, 16:1n-7, 18:1n-7, 18:1n-9, 20:1n-9, 22:1n-9, and 24:1n-9.
[f] total of all PUFA, including n-3, n-6, 16:2n-4, 16:3n-4, and 18:3n-4.
[g] (F) indicates farmed species and (W) indicates wild species. All unlabeled species are wild.

Table 2.2. Important SFA and MUFA in commercial U.S. finfish (mg/100 g).

Species	n[a]	14:0	16:0	18:0	18:1n-9
Amberjack, Greater	2	2.3 ± 0.5	92 ± 11	43 ± 3.9	33 ± 8.0
Amberjack, Yellowtail	2	81 ± 9.1	428 ± 45	152 ± 11	335 ± 15
Bass, Striped (F)[b]	5	162 ± 66	1098 ± 284	178 ± 43	1843 ± 441
Bass, Striped (W)[b]	5	97 ± 57	382 ± 161	81 ± 24	240 ± 108
Bluefish	3	155 ± 99	808 ± 562	252 ± 181	562 ± 434
Catfish, Channel (F)	11	72 ± 17	1297 ± 294	330 ± 91	3227 ± 802
Cod, Atlantic (F)	1	4.1 ± 0.1	98 ± 6.8	25 ± 1.6	44 ± 3.3
Cod, Atlantic (W)	8	4.9 ± 1.1	93 ± 12	23 ± 3.8	17 ± 6.6
Cod, Lingcod	4	26 ± 12	154 ± 43	40 ± 8.8	121 ± 58
Cod, Pacific	2	3.4 ± 0.6	77 ± 16	19 ± 3.1	31 ± 6.7
Cod, Sablefish	4	430 ± 149	2417 ± 454	428 ± 52	4474 ± 542
Croaker, Atlantic	5	92 ± 76	1059 ± 788	218 ± 146	621 ± 485
Flatfish, American Plaice	2	199 ± 162	261 ± 138	52 ± 16	215 ± 169
Flatfish, English Sole	2	33 ± 14	159 ± 59	37 ± 10	118 ± 52
Flatfish, Grey Sole	2	7.0 ± 4.2	78 ± 12	23 ± 3.8	22 ± 5.6
Flatfish, Gulf Flounder	2	2.8 ± 1.6	57 ± 10	20 ± 2.2	21 ± 3.4
Flatfish, Pacific Dover Sole	4	13 ± 4.5	94 ± 14	26 ± 8.4	43 ± 4.7
Flatfish, Petrale Sole	4	26 ± 3.3	164 ± 18	36 ± 3.1	113 ± 26
Flatfish, Rex Sole	2	9.3 ± 1.9	103 ± 14	27 ± 6.4	35 ± 6.2
Flatfish, Southern Flounder	1	4.0 ± 1.4	67 ± 9.5	25 ± 3.6	30 ± 7.4
Flatfish, Summer Flounder	5	14 ± 9.4	123 ± 40	33 ± 10	58 ± 42
Flatfish, Winter Flounder	1	37 ± 2.5	172 ± 7.5	41 ± 0.6	97 ± 7.4
Flatfish, Yellowtail Flounder	2	15 ± 3.1	94 ± 12	26 ± 2.9	45 ± 3.2
Grouper (unspecified)	3	36 ± 21	219 ± 105	64 ± 28	178 ± 122
Grouper, Gag	2	4.2 ± 1.0	70 ± 3.2	35 ± 1.6	42 ± 3.3
Grouper, Red	4	15 ± 6.7	114 ± 17	44 ± 3.6	59 ± 6.6
Grouper, Yellowedge	1	3.9 ± 0.9	82 ± 2.5	29 ± 0.5	46 ± 5.1
Haddock	4	4.0 ± 1.0	76 ± 12	21 ± 3.6	26 ± 7.6
Hake, Silver	2	4.2 ± 2.4	88 ± 7.2	25 ± 2.9	35 ± 8.8
Halibut, Alaskan	10	48 ± 90	165 ± 211	41 ± 30	211 ± 443
Halibut, California	2	8.6 ± 3.6	86 ± 21	28 ± 6.4	35 ± 11
Mackerel, King	1	23 ± 1.8	299 ± 37	121 ± 16	194 ± 10
Mackerel, Spanish	2	58 ± 20	858 ± 135	288 ± 28	800 ± 106
Mahi Mahi	11	7.3 ± 5.3	90 ± 43	47 ± 11	67 ± 32
Monkfish	9	3.8 ± 1.3	62 ± 5.8	21 ± 3.0	37 ± 7.2
Mullet, Striped	2	92 ± 101	627 ± 630	85 ± 54	147 ± 148
Pangasius/Swai (F)	8	37 ± 17	310 ± 137	94 ± 43	378 ± 190
Perch, Pacific Ocean	2	90 ± 46	477 ± 229	84 ± 31	434 ± 85
Perch, White	2	125 ± 9.9	963 ± 59	137 ± 11	1148 ± 55
Perch, Yellow	2	9.3 ± 3.3	113 ± 14	34 ± 3.1	40 ± 6.5
Pollock, Alaskan	7	5.3 ± 1.9	98 ± 21	30 ± 6.3	36 ± 13
Pollock, Atlantic	4	5.9 ± 3.4	118 ± 26	38 ± 8.5	74 ± 28

Table 2.2. (cont.)

Species	n[a]	14:0	16:0	18:0	18:1n9
Pompano, Florida	2	320 ± 105	3016 ± 508	1022 ± 204	2412 ± 540
Rockfish, Brown	2	45 ± 12	211 ± 16	52 ± 3.7	163 ± 34
Rockfish, Widow	2	46 ± 39	217 ± 82	51 ± 12	141 ± 86
Roughy, Orange	5	26 ± 6.0	79 ± 20	26 ± 7.7	1511 ± 436
Salmon, Atlantic (F)	11	489 ± 236	1895 ± 532	533 ± 209	3764 ± 1604
Salmon, Chinook (F)	2	446 ± 72	2599 ± 485	643 ± 141	4803 ± 419
Salmon, Chinook (W)	5	328 ± 149	1268 ± 162	291 ± 40	1685 ± 288
Salmon, Coho	7	119 ± 76	469 ± 197	93 ± 27	387 ± 134
Salmon, Sockeye	6	142 ± 64	590 ± 212	96 ± 26	591 ± 247
Scup	2	52 ± 44	378 ± 276	154 ± 107	384 ± 363
Sea Bass, Black	3	25 ± 14	208 ± 82	58 ± 16	148 ± 82
Sea Bass, Chilean	3	1851 ± 1216	2969 ± 1129	550 ± 200	8685 ± 1873
Sea Bass, White	2	6.2 ± 3.9	95 ± 28	35 ± 8.0	36 ± 16
Seatrout, Spotted	1	149 ± 2.6	866 ± 17	179 ± 3.5	427 ± 13
Shad, American	1	132 ± 1.4	441 ± 10	78 ± 2.1	199 ± 5.0
Shark, Common Thresher	1	4.0 ± 0.0	107 ± 2.2	54 ± 1.0	35 ± 5.4
Shark, Spiny Dogfish	2	77 ± 46	936 ± 550	176 ± 81	842 ± 466
Skate	2	4.0 ± 0.2	115 ± 9.8	24 ± 2.0	37 ± 2.7
Smelt, Rainbow	2	81 ± 8.9	317 ± 45	50 ± 4.4	233 ± 15
Snapper, Red	7	24 ± 19	170 ± 83	56 ± 30	104 ± 73
Snapper, Vermilion	2	22 ± 19	160 ± 52	62 ± 22	58 ± 15
Snapper, Yellowtail	3	28 ± 17	211 ± 138	73 ± 43	92 ± 69
Spot	2	260 ± 153	2872 ± 1370	621 ± 276	2101 ± 1044
Sturgeon, Green (F)	1	368 ± 37	2304 ± 206	347 ± 21	3983 ± 331
Sturgeon, White (F)	1	329 ± 6.3	2061 ± 36	285 ± 6.2	3263 ± 79
Sturgeon, White (W)	1	139 ± 5.1	1205 ± 58	148 ± 4.3	1564 ± 32
Swordfish	12	159 ± 115	979 ± 546	316 ± 191	1904 ± 1236
Tilapia (F)	11	73 ± 41	519 ± 223	134 ± 53	566 ± 275
Tilefish, (Mexico)	1	2.8 ± 0.4	78 ± 0.1	23 ± 0.2	31 ± 0.3
Tilefish, (North)	1	5.0 ± 0.7	87 ± 4.8	23 ± 1.2	50 ± 3.6
Trout, Lake	2	149 ± 74	814 ± 260	177 ± 30	1040 ± 243
Trout, Rainbow (F)	9	170 ± 62	986 ± 346	250 ± 115	1157 ± 616
Trout, Rainbow (W)	1	97 ± 5.6	801 ± 49	230 ± 14	1077 ± 63
Tuna, Albacore	3	238 ± 172	1434 ± 851	443 ± 280	1091 ± 721
Tuna, Bluefin	1	1657 ± 12	4348 ± 58	1019 ± 23	3895 ± 73
Tuna, Yellowfin	6	10 ± 13	128 ± 82	55 ± 25	84 ± 59
Wahoo	2	25 ± 17	438 ± 266	122 ± 69	328 ± 246
Walleye	2	42 ± 42	226 ± 156	34 ± 19	255 ± 255
Whitefish, Lake	6	134 ± 40	639 ± 127	105 ± 21	737 ± 163
Whiting, Pacific	2	36 ± 6.1	266 ± 21	42 ± 1.3	157 ± 26

[a] number of composite samples; each composite contains three fish.
[b] (F) indicates farmed species and (W) indicates wild species. All unlabeled species are wild.

Table 2.3. Important PUFA in commercial U.S. finfish (mg/100 g).

Species	n[a]	LNA 18:2n-6	ALA 18:3n-3	GLA 18:3n-6	SDA 18:4n-3	ARA 20:4n-6	EPA 20:5n-3	DPAn-3 22:5n-3	DHA 22:6n-3
Amberjack, Greater	2	3.9 ± 0.3	*nd*[b]	*nd*	*nd*	31 ± 7.8	11 ± 0.9	13 ± 1.0	125 ± 15
Amberjack, Yellowtail	2	27 ± 4.0	14 ± 4.9	2.9 ± 0.4	22 ± 11	33 ± 4.5	157 ± 30	64 ± 9.6	442 ± 32
Bass, Striped (F)[c]	5	775 ± 166	79 ± 16	16 ± 4.2	24 ± 12	53 ± 6.8	234 ± 71	74 ± 21	267 ± 63
Bass, Striped (W)[c]	5	26 ± 16	26 ± 20	3.7 ± 3.1	36 ± 25	37 ± 11	178 ± 88	52 ± 20	293 ± 88
Bluefish	3	44 ± 29	38 ± 33	5.0 ± 3.6	43 ± 24	63 ± 44	166 ± 98	94 ± 65	523 ± 313
Catfish, Channel (F)	11	983 ± 227	61 ± 12	27 ± 5.9	5.0 ± 1.9	53 ± 12	8.5 ± 2.4	11 ± 2.7	35 ± 9.0
Cod, Atlantic (F)	1	3.1 ± 0.5	1.1 ± 0.2	*nd*	1.7 ± 0.1	19 ± 0.3	85 ± 4.8	7.8 ± 0.3	168 ± 9.6
Cod, Atlantic (W)	8	3.9 ± 1.2	1.1 ± 0.5	*nd*	2.3 ± 1.5	12 ± 3.6	74 ± 24	7.4 ± 2.5	167 ± 29
Cod, Lingcod	4	10 ± 3.8	4.6 ± 1.6	*nd*	11 ± 5.0	17 ± 4.9	99 ± 23	14 ± 5.0	202 ± 29
Cod, Pacific	2	2.1 ± 0.3	*nd*	*nd*	*nd*	16 ± 3.3	62 ± 9.9	7.0 ± 0.6	134 ± 29
Cod, Sablefish	4	124 ± 24	61 ± 26	8.4 ± 3.9	102 ± 85	102 ± 20	653 ± 493	125 ± 49	566 ± 354
Croaker, Atlantic	5	28 ± 20	17 ± 13	2.8 ± 2.5	26 ± 23	63 ± 18	207 ± 135	106 ± 64	287 ± 126
Flatfish, American Plaice	2	23 ± 16	12 ± 9.7	*nd*	10 ± 5.2	39 ± 9.0	160 ± 51	29 ± 12	126 ± 27
Flatfish, English Sole	2	6.8 ± 1.3	3.2 ± 0.8	*nd*	6.4 ± 2.3	24 ± 1.6	130 ± 41	29 ± 3.7	130 ± 34
Flatfish, Grey Sole	2	3.1 ± 0.6	*nd*	*nd*	*nd*	30 ± 1.2	59 ± 7.2	19 ± 2.0	79 ± 5.8
Flatfish, Gulf Flounder	2	2.0 ± 0.6	*nd*	*nd*	*nd*	27 ± 1.1	9.9 ± 3.1	13 ± 8.9	52 ± 3.3
Flatfish, Pacific Dover Sole	4	4.6 ± 1.4	1.2 ± 0.9	*nd*	2.3 ± 1.0	25 ± 7.0	70 ± 10	22 ± 4.8	90 ± 14
Flatfish, Petrale Sole	4	7.1 ± 0.8	3.4 ± 0.4	*nd*	7.9 ± 1.1	15 ± 1.2	102 ± 12	31 ± 4.1	180 ± 14
Flatfish, Rex Sole	2	5.6 ± 2.2	*nd*	*nd*	2.4 ± 0.8	20 ± 0.5	82 ± 13	19 ± 3.8	107 ± 6.0
Flatfish, Southern Flounder	1	2.7 ± 0.5	*nd*	*nd*	*nd*	31 ± 2.6	13 ± 2.1	12 ± 0.8	73 ± 11
Flatfish, Summer Flounder	5	3.8 ± 1.7	*nd*	*nd*	2.0 ± 1.3	20 ± 5.8	30 ± 14	26 ± 14	156 ± 29
Flatfish, Winter Flounder	1	13 ± 1.5	8.3 ± 1.2	*nd*	35 ± 9.6	37 ± 1.3	179 ± 37	36 ± 6.2	194 ± 38
Flatfish, Yellowtail Flounder	2	5.4 ± 1.3	2.1 ± 0.9	*nd*	9.5 ± 8.0	15 ± 2.7	103 ± 19	19 ± 6.3	141 ± 11
Grouper (unspecified)	3	11 ± 6.0	4.5 ± 3.3	*nd*	2.7 ± 2.5	35 ± 13	42 ± 24	35 ± 16	168 ± 57
Grouper, Gag	2	3.8 ± 0.2	*nd*	*nd*	*nd*	30 ± 3.8	12 ± 2.9	9.4 ± 0.7	108 ± 5.1
Grouper, Red	4	4.8 ± 0.7	*nd*	*nd*	1.0 ± 1.9	38 ± 9.6	13 ± 2.8	15 ± 7.9	87 ± 37
Grouper, Yellowedge	1	2.7 ± 0.2	*nd*	*nd*	*nd*	21 ± 0.3	12 ± 0.5	13 ± 1.2	123 ± 2.3
Haddock	4	2.6 ± 0.4	*nd*	*nd*	1.4 ± 1.2	14 ± 2.3	69 ± 15	9.4 ± 0.9	110 ± 26
Hake, Silver	2	3.8 ± 1.0	*nd*	*nd*	*nd*	7.7 ± 1.1	36 ± 3.3	7.1 ± 0.3	178 ± 21

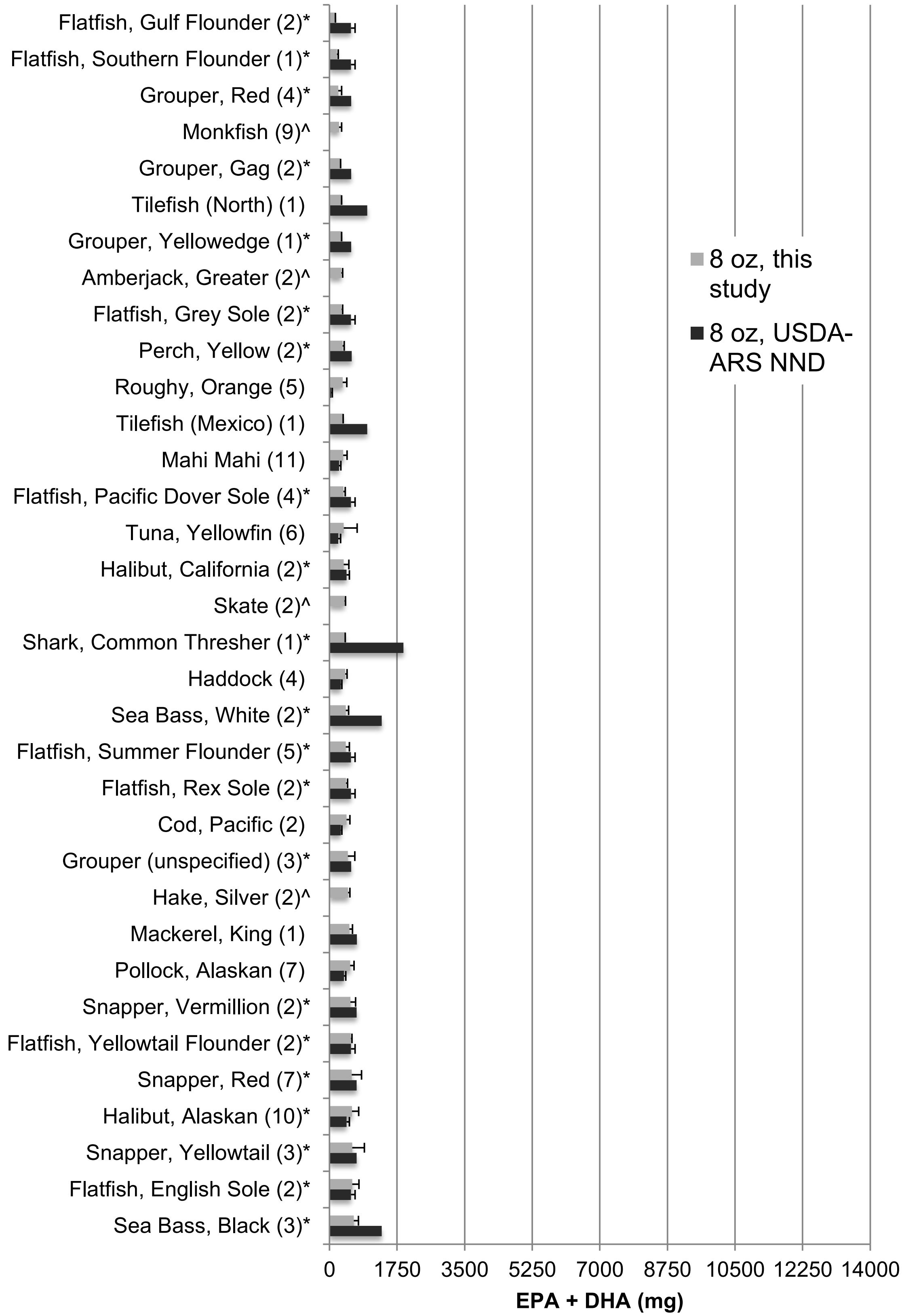
Table 2.3. (cont.)

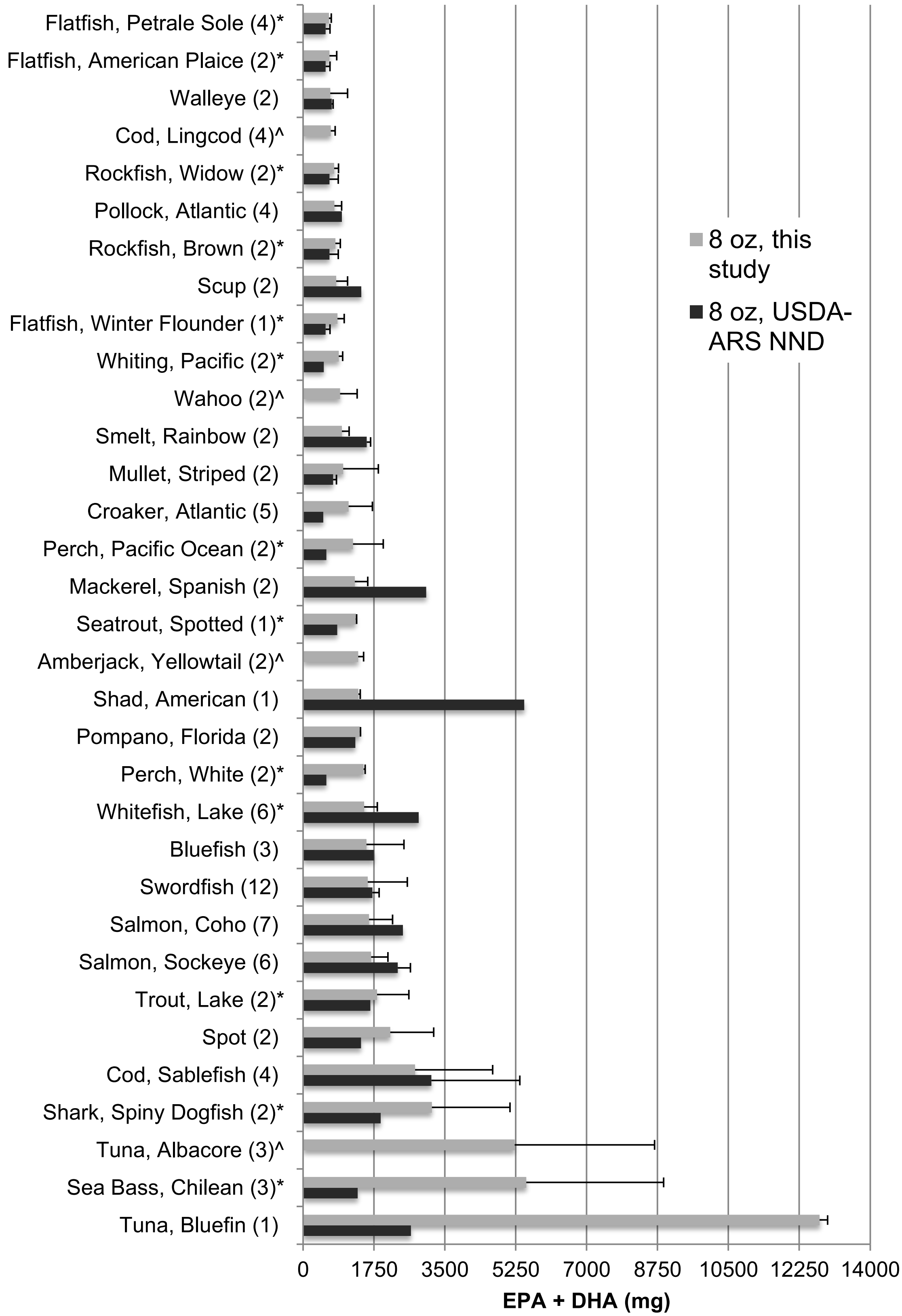
Species	n[a]	LNA 18:2n-6	ALA 18:3n-3	GLA 18:3n-6	SDA 18:4n-3	ARA 20:4n-6	EPA 20:5n-3	DPAn-3 22:5n-3	DHA 22:6n-3
Halibut, Alaskan	10	14 ± 23	5.4 ± 11	*nd*[b]	9.7 ± 17	18 ± 7.8	90 ± 36	20 ± 11	166 ± 45
Halibut, California	2	4.1 ± 1.2	*nd*	*nd*	1.2 ± 1.4	16 ± 1.7	25 ± 6.5	20 ± 3.3	139 ± 50
Mackerel, King	1	13 ± 1.6	4.9 ± 0.5	1.3 ± 0.2	3.3 ± 0.1	47 ± 7.1	42 ± 5.0	20 ± 2.5	186 ± 29
Mackerel, Spanish	2	35 ± 2.3	15 ± 11	3.2 ± 0.6	11 ± 5.6	69 ± 12	102 ± 36	37 ± 11	461 ± 105
Mahi Mahi	11	4.4 ± 1.4	*nd*	*nd*	*nd*	26 ± 4.8	17 ± 7.0	8.0 ± 3.6	139 ± 39
Monkfish	9	4.5 ± 1.1	*nd*	*nd*	*nd*	12 ± 3.6	22 ± 7.7	4.7 ± 2.2	86 ± 24
Mullet, Striped	2	61 ± 64	19 ± 21	13 ± 13	161 ± 184	56 ± 10	174 ± 153	68 ± 41	263 ± 231
Pangasius/Swai (F)	8	96 ± 46	5.0 ± 2.5	2.8 ± 1.4	*nd*	20 ± 4.6	2.1 ± 0.9	3.9 ± 0.9	15 ± 5.5
Perch, Pacific Ocean	2	34 ± 7.6	15 ± 7.5	2.9 ± 1.8	45 ± 36	26 ± 8.0	272 ± 212	22 ± 14	272 ± 116
Perch, White	2	166 ± 20	156 ± 13	11 ± 0.8	36 ± 5.0	218 ± 6.7	345 ± 12	119 ± 8.6	313 ± 16
Perch, Yellow	2	18 ± 1.5	5.3 ± 1.1	*nd*	2.4 ± 0.5	34 ± 4.0	52 ± 6.8	14 ± 1.7	99 ± 9.0
Pollock, Alaskan	7	4.1 ± 3.0	*nd*	*nd*	2.2 ± 0.5	6.8 ± 2.2	88 ± 19	7.4 ± 2.2	148 ± 27
Pollock, Atlantic	4	7.4 ± 4.0	2.3 ± 1.4	*nd*	2.2 ± 1.6	16 ± 3.3	69 ± 17	8.9 ± 3.4	271 ± 67
Pompano, Florida	2	43 ± 4.0	32 ± 9.1	9.7 ± 0.2	27 ± 5.9	157 ± 10	148 ± 23	204 ± 29	469 ± 26
Rockfish, Brown	2	14 ± 3.1	5.8 ± 1.8	*nd*	9.4 ± 3.9	21 ± 3.9	107 ± 15	23 ± 2.2	244 ± 41
Rockfish, Widow	2	14 ± 4.6	5.7 ± 4.0	*nd*	11 ± 8.0	13 ± 2.5	110 ± 51	16 ± 5.3	228 ± 10
Roughy, Orange	5	42 ± 12	11 ± 7.4	6.2 ± 9.9	5.6 ± 4.9	29 ± 14	40 ± 19	6.8 ± 6.3	112 ± 29
Salmon, Atlantic (F)	11	2207 ± 1386	406 ± 191	28 ± 13	131 ± 91	66 ± 17	664 ± 271	333 ± 126	845 ± 470
Salmon, Chinook (F)	2	963 ± 345	154 ± 19	18 ± 1.7	112 ± 4.9	75 ± 4.6	737 ± 241	272 ± 90	796 ± 130
Salmon, Chinook (W)	5	76 ± 34	52 ± 26	4.4 ± 2.5	100 ± 65	35 ± 4.0	496 ± 40	184 ± 51	610 ± 141
Salmon, Coho	7	32 ± 15	24 ± 12	2.3 ± 1.9	45 ± 29	17 ± 4.3	227 ± 81	74 ± 24	490 ± 190
Salmon, Sockeye	6	56 ± 24	30 ± 12	2.7 ± 1.0	46 ± 18	18 ± 5.0	262 ± 93	75 ± 26	479 ± 93
Scup	2	11 ± 5.4	4.2 ± 3.1	*nd*	6.0 ± 3.1	61 ± 29	131 ± 63	74 ± 37	229 ± 62
Sea Bass, Black	3	8.7 ± 2.4	3.8 ± 1.1	*nd*	4.7 ± 1.6	27 ± 5.8	85 ± 33	28 ± 8.3	193 ± 23
Sea Bass, Chilean	3	431 ± 280	124 ± 72	32 ± 21	245 ± 169	128 ± 51	1277 ± 951	102 ± 28	1153 ± 560
Sea Bass, White	2	5.0 ± 1.9	*nd*	*nd*	1.3 ± 1.5	17 ± 0.8	27 ± 11	7.8 ± 0.4	157 ± 23
Seatrout, Spotted	1	85 ± 2.0	66 ± 1.4	21 ± 0.5	41 ± 0.9	123 ± 2.1	191 ± 4.2	87 ± 2.1	382 ± 4.3
Shad, American	1	30 ± 0.7	17 ± 0.5	2.6 ± 0.1	32 ± 0.8	18 ± 0.5	133 ± 3.3	45 ± 0.8	470 ± 15
Shark, Common Thresher	1	3.4 ± 1.8	*nd*	*nd*	*nd*	28 ± 0.4	13 ± 0	38 ± 0.5	166 ± 2.6

Table 2.3. (cont.)

Species	n[a]	LNA 18:2n-6	ALA 18:3n-3	GLA 18:3n-6	SDA 18:4n-3	ARA 20:4n-6	EPA 20:5n-3	DPAn-3 22:5n-3	DHA 22:6n-3
Shark, Spiny Dogfish	2	93 ± 51	36 ± 23	5.2 ± 3.2	48 ± 30	133 ± 79	337 ± 206	119 ± 70	1064 ± 646
Skate	2	6.6 ± 0.3	1.8 ± 0	*nd*[b]	1.3 ± 0.1	18 ± 1.8	32 ± 2.7	20 ± 1.4	139 ± 9.0
Smelt, Rainbow	2	89 ± 6.4	88 ± 20	5.7 ± 0.3	58 ± 27	73 ± 5.4	173 ± 13	26 ± 14	248 ± 76
Snapper, Red	7	9.0 ± 5.6	3.6 ± 3.9	*nd*	6.1 ± 9.2	26 ± 11	57 ± 54	15 ± 5.2	196 ± 66
Snapper, Vermilion	2	8.3 ± 4.6	2.6 ± 3.0	*nd*	3.0 ± 3.4	26 ± 6.3	32 ± 20	13 ± 2.8	207 ± 40
Snapper, Yellowtail	3	14 ± 5.4	5.4 ± 4.2	*nd*	3.3 ± 1.6	29 ± 10	37 ± 25	15 ± 12	222 ± 115
Spot	2	72 ± 50	38 ± 27	4.9 ± 3.5	42 ± 38	128 ± 56	485 ± 166	219 ± 43	464 ± 307
Sturgeon, Green (F)	1	1331 ± 115	84 ± 8.2	93 ± 8.8	50 ± 4.5	178 ± 10	404 ± 29	172 ± 12	663 ± 41
Sturgeon, White (F)	1	1109 ± 31	80 ± 2.5	48 ± 1.8	48 ± 1.9	112 ± 1.7	410 ± 8.9	155 ± 2.9	529 ± 4.9
Sturgeon, White (W)	1	161 ± 3.6	131 ± 4.9	11.7 ± 0.1	65 ± 2.0	226 ± 7.4	511 ± 16	161 ± 6.7	156 ± 5.0
Swordfish	12	43 ± 34	17 ± 16	1.7 ± 2.1	13 ± 22	60 ± 30	130 ± 133	123 ± 81	574 ± 327
Tilapia (F)	11	268 ± 133	20 ± 7.9	14 ± 7.1	2.5 ± 1.5	38 ± 8.5	5.9 ± 2.1	21 ± 10	70 ± 21
Tilefish, (Mexico)	1	2.2 ± 0	*nd*	*nd*	*nd*	18 ± 0.5	13 ± 0.1	10 ± 0.1	141 ± 3.8
Tilefish, (North)	1	2.7 ± 0.7	*nd*	*nd*	*nd*	18 ± 1.0	12 ± 1.0	17 ± 1.9	123 ± 3.2
Trout, Lake	2	166 ± 68	115 ± 58	9.2 ± 4.9	49 ± 28	136 ± 42	234 ± 85	138 ± 47	571 ± 261
Trout, Rainbow (F)	9	471 ± 330	49 ± 20	10 ± 6.4	32 ± 13	51 ± 15	229 ± 125	89 ± 49	598 ± 179
Trout, Rainbow (W)	1	527 ± 29	35 ± 1.9	14 ± 1.1	12 ± 0.7	45 ± 1.7	64 ± 3.2	26 ± 1.1	264 ± 9.3
Tuna, Albacore	3	94 ± 66	51 ± 39	11 ± 7.4	110 ± 85	85 ± 48	646 ± 492	108 ± 87	1658 ± 1046
Tuna, Bluefin	1	515 ± 2.5	317 ± 1.9	47 ± 1.2	675 ± 7.1	193 ± 3.1	2097 ± 36	368 ± 9.1	3526 ± 52
Tuna, Yellowfin	6	6.1 ± 4.2	1.4 ± 2.3	*nd*	1.5 ± 2.8	23 ± 7.0	26 ± 29	8.3 ± 6.8	135 ± 81
Wahoo	2	14 ± 8.2	2.6 ± 3.1	*nd*	4.1 ± 2.3	36 ± 17	45 ± 23	25 ± 18	356 ± 163
Walleye	2	52 ± 52	46 ± 45	2.5 ± 2.9	18 ± 17	64 ± 43	109 ± 76	30 ± 20	186 ± 111
Whitefish, Lake	6	142 ± 42	108 ± 32	12 ± 3.5	77 ± 33	118 ± 20	277 ± 60	100 ± 15	387 ± 103
Whiting, Pacific	2	15 ± 2.3	8.3 ± 2.7	1.2 ± 0.1	17 ± 4.1	13 ± 1.7	193 ± 17	11 ± 1.0	196 ± 25

[a] number of composite samples; each composite contains three fish.
[b] nd indicates samples that were below the limits of quantitation or not detected. The LOQ was 1 mg/100 g.
[c] (F) indicates farmed species and (W) indicates wild species. All unlabeled species are wild.


Flatfish, Gulf Flounder (2)*
Flatfish, Southern Flounder (1)*
Grouper, Red (4)*
Monkfish (9)^
Grouper, Gag (2)*
Tilefish (North) (1)
Grouper, Yellowedge (1)*
Amberjack, Greater (2)^
Flatfish, Grey Sole (2)*
Perch, Yellow (2)*
Roughy, Orange (5)
Tilefish (Mexico) (1)
Mahi Mahi (11)
Flatfish, Pacific Dover Sole (4)*
Tuna, Yellowfin (6)
Halibut, California (2)*
Skate (2)^
Shark, Common Thresher (1)*
Haddock (4)
Sea Bass, White (2)*
Flatfish, Summer Flounder (5)*
Flatfish, Rex Sole (2)*
Cod, Pacific (2)
Grouper (unspecified) (3)*
Hake, Silver (2)^
Mackerel, King (1)
Pollock, Alaskan (7)
Snapper, Vermillion (2)*
Flatfish, Yellowtail Flounder (2)*
Snapper, Red (7)*
Halibut, Alaskan (10)*
Snapper, Yellowtail (3)*
Flatfish, English Sole (2)*
Sea Bass, Black (3)*
8 oz, this study
8 oz, USDA-ARS NND
0
1750
3500
5250
7000
8750
10500
12250
14000
EPA + DHA (mg)



Flatfish, Petrale Sole (4)*
Flatfish, American Plaice (2)*
Walleye (2)
Cod, Lingcod (4)^
Rockfish, Widow (2)*
Pollock, Atlantic (4)
Rockfish, Brown (2)*
Scup (2)
Flatfish, Winter Flounder (1)*
Whiting, Pacific (2)*
Wahoo (2)^
Smelt, Rainbow (2)
Mullet, Striped (2)
Croaker, Atlantic (5)
Perch, Pacific Ocean (2)*
Mackerel, Spanish (2)
Seatrout, Spotted (1)*
Amberjack, Yellowtail (2)^
Shad, American (1)
Pompano, Florida (2)
Perch, White (2)*
Whitefish, Lake (6)*
Bluefish (3)
Swordfish (12)
Salmon, Coho (7)
Salmon, Sockeye (6)
Trout, Lake (2)*
Spot (2)
Cod, Sablefish (4)
Shark, Spiny Dogfish (2)*
Tuna, Albacore (3)^
Sea Bass, Chilean (3)*
Tuna, Bluefin (1)
8 oz, this study
8 oz, USDA-ARS NND
0
1750
3500
5250
7000
8750
10500
12250
14000
EPA + DHA (mg)

Figure 2.1. EPA plus DHA content in eight ounces of wild caught species collected in this study, with a comparison to the USDA-ARS NND [23]. Numbers in parentheses represent the number of composites (three fish each) collected for each species. *Indicates that USDA-ARS NND data are not specific to the species, but are the closest approximation. For example, all flatfish are listed as "flatfish – flounder and sole species", while the current study differentiates between individual species. ^Indicates that no data are available on the EPA plus DHA content in the USDA-ARS NND.

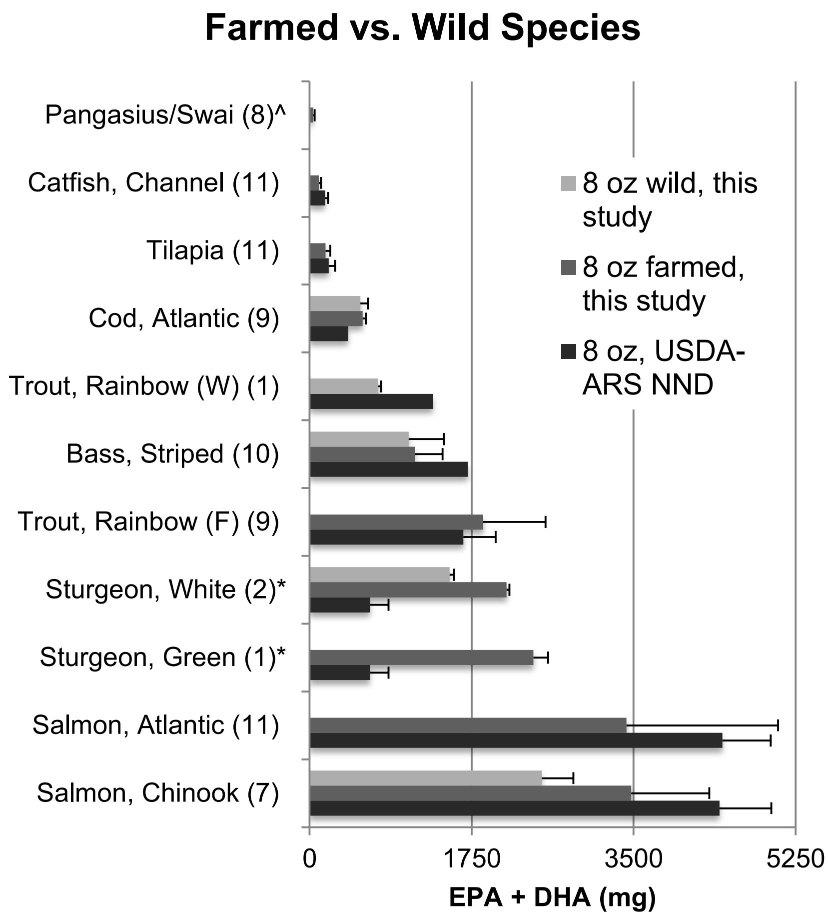


Figure 2.2. EPA plus DHA content in eight ounces of the farmed species collected in this study. A comparison to the USDA-ARS NND [23] is also shown, which does not distinguish between farmed and wild fish except for rainbow trout. Numbers in parentheses represent the number of composites (three fish each) collected for each species. *Indicates that USDA-ARS NND data are not specific to the species, but are the closest approximation. ^Indicates that no data are available on the EPA plus DHA content in the USDA-ARS NND.

CHAPTER 3. MERCURY CONTENT IN COMMERCIALLY-AVAILABLE FINFISH IN THE U.S.

This manuscript has been submitted to the *Journal of Food Protection* and is written in the style required by the journal.

3.1. Abstract

Seventy seven finfish species (300 composites of three fish) were obtained from commercial vendors in six regions of the U.S. (Great Lakes, Mid-Atlantic, New England, Northwest, Southeast and Southwest). Total mercury in fish muscle tissue ranged from 1 ppb (channel catfish) to 1425 ppb (king mackerel). Of the top ten most commonly consumed seafoods, all finfish species, including salmon (13 – 62 ppb), Alaskan Pollock (11 ppb), tilapia (16 ppb), channel catfish (1 ppb), Atlantic cod (82 ppb), and pangasius/swai (2 ppb) all had low total mercury levels. However, two large predatory species, king mackerel (1425 ppb) and swordfish (1107 ppb), contained mercury concentrations above the current FDA Action Level of 1000 ppb, indicating that consumers may be unaware that species which are higher in mercury are being sold in the marketplace.

3.2. Keywords

Mercury, methylmercury, commercial fish, consumption advice, seafood safety.

3.3. Introduction

Mercury is a persistent environmental contaminant from natural sources and the combustion of waste *(19, 21)*. Mercury converts to methylmercury via aquatic microorganisms and bioaccumulates in fish *(7, 18)*. Large predatory fish generally have higher tissue mercury concentrations *(8, 24)*, due to their increased exposure and the long half-life of methylmercury *(16, 31)*. In humans, methylmercury is efficiently absorbed *(33)* and exhibits a half-life of 45 – 70 days *(7)*.

Excessive exposure to methylmercury can cause injury to the brain and central nervous system *(6, 10, 11, 18)*. These affects were most prominently noted during outbreaks of methylmercury poisoning in Iraq *(2)* and Japan *(14)*. The neurotoxicity of methylmercury derives from the fact that 10% of the body burden of methylmercury is found in the brain *(23)*, where it is slowly demethylated to inorganic mercury, which can lead to the development of brain lesions *(18)*. This is especially important for neonates, as the mercury consumed by the mother is passed directly to the infant *(9, 23)*. Fetuses exposed to methylmercury can exhibit delays in language development, attention, memory, motor skill development, and learning ability *(12, 13, 20)*. These deficits can be observed in children exposed to methylmercury, even if their mothers are asymptomatic *(7)*. The U.S. Environmental Protection Agency (USEPA) has established a Reference Dose (RfD) for mercury of 0.1 μg/kg bw-day *(27)*. This RfD corresponds to hair mercury levels of up to 1000 ppb, which should not be exceeded by pregnant and nursing women, as fetal neurodevelopmental effects have been observed with maternal hair levels exceeding 1200 ppb *(20)*.

The primary source of methylmercury exposure is seafood *(7)*. In 2012, Americans consumed an average of 14.4 pounds of seafood per capita *(17)*. To help protect sensitive populations from the harmful effects of methylmercury, in 2004 the U.S. Food and Drug Administration (FDA) and USEPA jointly published guidelines for fish consumption *(28)*. The FDA has established an Action Level of 1000 ppb total mercury in commercial fish *(29)*, while the USEPA recommends a lower level of 185 ppb, based on the RfD *(25)*. Health Canada has set a limit of 500 ppb mercury in commercial fish, with the exception of six species (escolar, orange roughy, marlin, tuna, shark and swordfish) that may have up to 1000 ppb mercury *(15)*. The objective of this study was to survey the mercury content of a wide variety of commercially-available finfish from across the U.S.

3.4. Materials and Methods

3.4.1. Collection Protocol

Fish were obtained from commercial vendors in six regions of the U.S., including the Great Lakes (GL), Mid-Atlantic (MA), New England (NE), Northwest (NW), Southeast (SE) and Southwest (SW). Three samples of at least 200 g were requested for each species in addition to tracking information (vendor, supplier, wild or farm raised, country/body of water of origin), length, and weight of each fish. Photos were taken by vendors and sent with the samples to ensure positive identification of each species. Samples were collected for each species during two seasons, 4-12 months apart, for each region. In total, 77 species (300 composites of three fish) were collected during this study. The tested species along with full tracking details, including the date received, region, and origin of all samples, are available at www.fish4health.net.

Fish species were divided into three categories for collection. The "top ten species" are the finfish species from the National Marine Fisheries Service list of the most commonly consumed seafoods in the U.S. *(17)* The "other popular species" include fish commonly consumed across the U.S. that are higher in n-3 fatty acids or mercury. Finally, to include species that are popular in different parts of the country, experts in each region were consulted in the development of "regionally-popular species" lists. All regions except MA were asked to provide "top ten", "other popular", and "regionally-popular" species. For the MA region, only swordfish and striped bass from the "other popular species" list were requested in addition to the "regionally-popular species".

The "top ten species" included Atlantic salmon (*Salmo salar*), Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), sockeye salmon (*Oncorhynchus nerka*), Alaskan pollock (*Theragra chalcogramma*), tilapia (family: cichlidae; tribe: tilapiini), channel catfish (*Ictalurus punctatus*), Atlantic cod (*Gadus morhua*), and pangasius/swai (*Pangasius hypophthalmus*). The "other popular species" included striped bass (*Morone saxatilis*), swordfish (*Xiphias gladius*), Alaskan halibut (*Hippoglossus stenolepis*), rainbow trout (*Oncorhynchus mykiss*), monkfish (*Lophius* spp.), red snapper (*Lutjanus campechanus*), grouper (family: *Serranidae*; subfamily: *Epiniphelus*) or red grouper (*Epinephelus morio*), black sea bass (*Centropristis striata*), mahi mahi (*Coryphaena hippurus*), and orange roughy (*Hoplostethus atlanticus*).

“Regionally-popular species” differed by region. GL vendors provided the following species: summer flounder (*Paralichthys dentatus*), bluefin tuna (*Thunnus thynnus*), lake trout (*Salvelinus namaycush*), walleye (*Sander vitreus*), yellow perch (*Perca flavescens*), lake whitefish (*Coregonus clupeaformis*), and rainbow smelt (*Osmerus mordax*). MA vendors provided the following species: striped bass, swordfish, Atlantic croaker (*Micropogonias undulatus*), bluefish (*Pomatomus saltatrix*), spot (*Leiostomus xanthurus*), summer flounder, white perch (*Morone americana*), scup (*Stenotomus chrysops*), spiny dogfish (*Squalus acanthias*), and skate (family: *Rajidae*). NE vendors provided the following species: yellowtail flounder (*Limanda ferruginea*), winter flounder (*Pseudopleuronectes americanus*), Atlantic pollock (*Pollachius pollachius*), yellowfin tuna (*Thunnus albacares*), haddock (*Melanogrammus aeglefinus*), grey sole (*Glyptocephalus cynoglossus*), silver hake (*Merluccius bilinearis*), tilefish – north Atlantic population (*Lopholatilus chamaeleonticeps*), American plaice (*Hippoglossoides platessoides*), and American shad (*Alosa sapidissima*). A NW vendor provided the following species: lingcod (*Ophiodon elongates*), sablefish (*Anoplopona fimbria*), Pacific cod (*Gadus macrocephalus*), Pacific Dover sole (*Microstomus pacificus*), English sole (*Parophrys vetulus*), petrale sole (*Eopsetta jordani*), rex sole (*Glyptocephalus zachirus*), white sturgeon (*Acipenser transmontanus*), green sturgeon (*Acipenser medirostris*), albacore tuna (*Thunnus alalunga*), brown rockfish (*Sebastes auriculatus*), widow rockfish (*Sebastes entomelas*), Pacific Ocean perch (*Sebastes alutus*), Pacific whiting (*Merluccius productus*), and Chilean sea bass (*Dissostichus eleginoides*). SE vendors provided the following species: king mackerel (*Scomeromorus cavalla*), tilefish – Gulf of Mexico population, Spanish mackerel (*Scomberomorus* *maculatus*), Atlantic croaker, greater amberjack (*Seriola dumerili*), striped mullet (*Mugil cephalus*), yellowfin tuna, gag grouper (*Mycteroperca microlepis*), yellowedge grouper (*Hyporthodus flavolimbatus*), yellowtail snapper (*Ocyurus chrysurus*), vermilion snapper (*Rhomboplites aurorubens*), Florida pompano (*Trachinotus carolinus*), spotted seatrout (*Cynoscion nebulosus*), Gulf flounder (*Paralichthys albigutta*), and southern flounder (*Paralichthys lethostigma*). A SW vendor provided the following species: Pacific Dover sole, petrale sole, common thresher shark (*Alopias vulpinus*), white sea bass (*Atractoscion nobilis*), California halibut (*Paralichthys californicus*), yellowtail amberjack (*Seriola lalandi*), sablefish, albacore tuna, wahoo (*Acanthocybium solandri*), lingcod, and Chilean sea bass.

3.4.2. Sample Preparation

Samples were packed on ice and sent via overnight shipping to Purdue University, where testing was completed. Upon arrival, the temperature of each sample was measured to ensure it was 7 °C or lower. All fish were immediately filleted, with skin and pin bones removed. Homogeneous composites of the three fillets of each species were created by grinding in a food processor (Robot-Coupe R2 Ultra, Robot Coupe USA, Inc., Ridgeland, MS, USA). Samples were packed in airtight, sterile sampling bags (Fisher Scientific, Pittsburgh, PA, USA) and frozen at –20 °C until analysis.

3.4.3. Mercury Measurement

Total mercury content was determined using a thermal decomposition (gold) amalgamation, atomic absorption spectrophotometer (TDA/AAS) direct mercury analyzer (DMA-80, Milestone Inc., Sheldon, CT, USA). The following operating conditions were used: samples were dried at 300 °C for 60 s and thermally decomposed at 850 °C for 180 s. Oxygen (commercial grade, 99.5% pure, Indiana Oxygen Company, Indianapolis, IN, USA) was used to purge the system for 60 s and remove interferences. The amalgamator was rapidly heated to 900 °C for 12 s to vaporize mercury and pass it to the detector, where the absorbance was measured at 253.65 nm for 30 s.

Calibration of the DMA-80 was achieved using a 1000 ppm mercury standard solution (AccuStandard, Inc., New Haven, CT, USA). Three dilute mercury solutions (0.100 ppm, 1.0 ppm, and 10.0 ppm mercury in 5% hydrochloric acid) were made and used for calibration. Two different calibration curves were developed for the two different cells (0 to 25 ng Hg and 25 to 600 ng Hg), yielding a working range of 0.02 ng Hg (limit of detection) to 600 ng Hg. Due to the large number of samples analyzed and the need to repeat many samples (see below), the catalyst was changed three times during this study. The amalgamator was changed with the first and third catalyst changes, yielding higher absorbancies and a longer catalyst life. Table 3.1 shows the calibration curves used for each of the three catalyst tubes, along with correlation coefficients.

There is some uncertainty in the literature as to whether solid standards (e.g., TORT-3, DORM-4, DOLT-4) or liquid standards are better for calibration *(4, 5)*, though both are accepted for use with USEPA Method 7473 *(26)*. Liquid samples were chosen for this analysis to achieve greater accuracy *(4)*.

Each composited fish sample (100 mg, wet weight) was analyzed in triplicate. Samples were randomized, however, lower mercury samples were run first to minimize errors resulting from carryover effects *(5)*. At the beginning of each run, a blank, a 50 mg sample of TORT-2, and a 100 mg sample of TORT-2 (Institute for National Measurement Standards, National Research Council of Canada, Ottawa, Canada) as a Standard Reference Material were run to validate the performance of the full working range of the instrument. Additional samples of TORT-2 were run every 20 replicates to continually monitor and validate proper performance. To limit carryover or memory effects in the instrument, blanks were run between each fish species, i.e., after every set of triplicates. Matrix effects with oily fish have been known to increase carryover effects *(22)*. To eliminate these effects, one boat with flour and one boat with 5-10% nitric acid were run every 10-15 replicates when running samples with high fat content *(22)*.

Results were rejected and the analysis repeated on all samples that had a relative standard deviation (RSD) greater than 10% between the three replicates. Exceptions to this were made for samples with low mercury concentrations ($\leq$ 20 ppb mercury), as RSD increases rapidly at low levels. This criterion was based upon the manufacturer's certification that five replicates of 100 mg of a 100 ppb Hg liquid standard will yield an RSD < 5% when the instrument is functioning properly *(22)*. Thus, to accommodate the use of composited muscle tissue samples, the RSD was doubled to 10% as the acceptance criterion between the replicates of fish tissue. Applying this criterion, 10.3% of samples failed and had to be retested.

3.5. Results

Total mercury concentration of all species obtained in this study, and a comparison to current FDA data *(30)*, is shown in Figure 3.1. Total mercury ranged from 1 ppb (channel catfish) to 1425 ppb (king mackerel). The "top ten species" are all low mercury species, with all species except farmed Atlantic cod having < 80 ppb total mercury. "Other popular species" and "regionally-popular species" showed large variations in mercury concentration.

All but two species (swordfish and king mackerel) contained average mercury concentrations below 1000 ppb, the FDA's current Action Level for fish sold in U.S. markets *(29)*. However, when considering the more conservative Health Canada limit of 500 ppb Hg in all species (except escolar, orange roughy, marlin, fresh/frozen tuna, shark, and swordfish, which may have up to 1000 ppb Hg) *(15)*, six additional species (gag grouper, red grouper, sablefish, north Atlantic tilefish, yellowedge grouper, and greater amberjack) exceeded the limit. The most conservative recommendations have been established by the USEPA, which advises against consumption of fish with more than 185 ppb Hg, calculated from the RfD of 0.1 μg/kg bw-d *(25)*. Based on this criterion, 27 species in this study should be avoided, including Alaskan halibut, albacore tuna, greater amberjack, bluefin tuna, bluefish, brown rockfish, Chilean sea bass, common thresher shark, gag grouper, king mackerel, mahi mahi, orange roughy, red grouper, rex sole, sablefish, Spanish mackerel, spiny dogfish, southern flounder, swordfish, tilefish (north Atlantic and Gulf of Mexico populations), wahoo, walleye, white sea bass, yellowedge grouper, yellowfin tuna, and yellowtail amberjack.

3.6. Discussion

3.6.1. Mercury in Popular U.S. Finfish

When comparing the data obtained in this study to FDA data *(30)*, agreement between the studies was generally good (Figure 3.1). The most noticeable feature of the data is the presence of large standard deviations in nearly all species, which is also present in the FDA data. This has been noted by others and can be attributed to the age and size of the fish as well as fish exposure levels *(3)*. A study by Wente (2004) modeled mercury concentration differences within 11 species, using fish length as the primary factor in estimating mercury *(32)*. All 11 species have different length-mercury curves, illustrating the role of fish size on mercury concentration.

One important aspect of the data presented here is the difference between species within a genus or family. For example, the average mercury concentration of groupers in this study ranged from 181 to 726 ppb, while the FDA establishes the average mercury concentration for grouper (all species) as 448 ppb *(30)*. This does not take into account the large variability between grouper species, which is exceedingly important for the creation of effective seafood advisories, especially for fish with relatively high levels of mercury. Several other fish "categories", including cod, flatfish, trout, sea bass, and shark also show differences between species within the same genus or family and would benefit from treatment as separate species. As the FDA database is the most comprehensive and complete source of mercury data for fish and shellfish, listing each species separately (rather than as a "category", like grouper or flatfish) would help expand the impact of the database and allow consumers to obtain specific advice for each species in the marketplace.

As mentioned in the results section above, swordfish (1107 ppb) and king mackerel (1425 ppb) had average mercury concentrations that exceed the FDA Action Level of 1000 ppb in commercial fish. The presence of these high mercury species in commercial markets may expose consumers to unsafe levels of mercury, and also indicates that consumers are not being adequately protected or informed.

3.6.2. Consumption Advice

The neurotoxic effects of methylmercury have been well documented, and special care has been urged for sensitive populations, including pregnant and nursing women, women who may become pregnant, and young children *(1)*. However, with varying meal portions in the modern diet, advisories on fish consumption should recommend exact amounts of fish that should be consumed (e.g., 12 ounces per week) rather than meal frequency (e.g., up to three meals per week) to maximize the usefulness of the results to consumers.

To determine appropriate levels of fish consumption for sensitive populations, a number of factors must be considered, including an individual's body weight (bw) and current regulatory guidelines. For the current study, exposure calculations were performed to determine appropriate consumption levels, based on the USEPA RfD for mercury of 0.1 μg/kg bw-d *(27)* and a body weight of 60 kg (132 lb). For sensitive populations, no more than 42 μg Hg/week should be consumed (60 kg bw * 0.1 μg/kg bw-d * 7 d/wk). To translate these figures into intake values, four consumption categories were created: safe to eat up to 12 oz/wk, 8 oz/wk, 4 oz/wk, and not safe to eat. For example, sensitive populations may safely consume up to 12 oz/wk of fish with < 123 ppb Hg (42 μg Hg/wk * 1 wk/12 oz * 1 oz/28.375 g). Table 3.2 outlines the categories for sensitive populations.

By following these proposed categories for fish consumption, sensitive populations will have more well established guidelines to follow when consuming seafood. Table 3.3 illustrates the species in this study that can be safely consumed within each of the categories. Even in the most restrictive category (< 123 ppb Hg), over half of the measured species are present and thus safe to eat. This flexibility is important for consumers, as individual preferences vary.

This study gives a broad overview of the myriad species of finfish available to U.S. consumers through commercial markets. The results provide more specificity within certain species (e.g., grouper) and confirm the large differences in mercury concentration within and between species. Overall, results compared well with FDA data and expand the number of species for which data are available. One key finding in this study is that consumers are not being protected from high mercury fish, as two species (swordfish and king mackerel) had average mercury concentrations above the FDA Action Level. Additionally, this work serves as a step toward helping to protect sensitive populations by establishing more definitive consumption advice for a larger number of species commonly consumed in the U.S. Monitoring mercury in fish is necessary to continually update and expand the information available to consumers so they can make informed decisions regarding seafood consumption.

3.7. Acknowledgments

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3.8. References

1. Agency for Toxic Substances and Disease Registry. 2012. Sensitive populations and chemical exposure. Available at: www.atsdr.cdc.gov/emes/public/docs/Sensitive%20Populations%20FS.pdf. Accessed 26 February 2014.

2. Bakir, F., S. F. Damluji, L. Amin-Zaki, M. Murtadha, A. Khalidi, N. Y. Al-Rawi, S. Tikriti, H. I. Dhahir, T. W. Clarkson, J. C. Smith, and R. A. Doherty. 1973. Methylmercury poisoning in Iraq. *Science*. 181:230-241.

3. Burger, J., and M. Gochfeld. 2011. Mercury and selenium levels in 19 species of saltwater fish from New Jersey as a function of species, size, and season. *Sci. Total Environ*. 409:1418-1429.

4. Butala, S. J. M., L. P. Scanlan, and S. N. Chaudhuri. 2006. A detailed study of thermal decomposition, amalgamation/atomic absorption spectrophotometry methodology for the quantitative analysis of mercury in fish and hair. *J. Food Prot*. 69:2720-2728.

5. Butala, S. J. M., L. P. Scanlan, S. N. Chaudhuri, D. D. Perry, and R. J. Taylor. 2007. Interlaboratory bias in the determination of mercury concentrations in commercially available fish utilizing thermal decomposition/amalgamation atomic absorption spectrophotometry. *J. Food Prot*. 70:2422-2425.

6. Ceccatelli, S., and M. Aschner (ed.). 2012. Methylmercury and neurotoxicity. Springer, New York, NY.

7. Clarkson, T. W., and L. Magos. 2006. The toxicology of mercury and its chemical compounds. *Crit. Rev. Toxicol*. 36:609-662.

8. Depew, D. C., N. M. Burgess, M. R. Anderson, R. Baker, S. P. Bhavsar, R. A. Bodaly, C. S. Eckley, M. S. Evans, N. Gantner, J. A. Graydon, K. Jacobs, J. E. LeBlanc, V. L. St. Louis, and L. M. Campbell. 2013. An overview of mercury concentrations in freshwater fish species: a national fish mercury dataset for Canada. *Can. J. Fish. Aquat. Sci*. 70:436-451.

9. Diez, S., S. Delgado, I. Aguilera, J. Astray, B. Perez-Gomez, M. Torrent, J. Sunyer, and J. M. Bayona. 2009. Prenatal and early childhood exposure to mercury and methylmercury in Spain, a high-fish-consumer country. *Arch. Environ. Contam. Toxicol*. 56:615-622.

10. Farina, M., J. B. T. Rocha, and M. Aschner. 2011. Mechanisms of methylmercury-induced neurotoxicity: evidence from experimental studies. *Life Sci*. 89:555-563.

11. Ferraro, L., M. C. Tomasini, S. Tanganelli, R. Mazza, A. Coluccia, M. R. Carratu, S. Gaetani, V. Cuomo, and T. Antonelli. 2009. Developmental exposure to methylmercury elicits early cell death in the cerebral cortex and long-term memory deficits in the rat. *Int. J. Dev. Neurosci*. 27:165-174.

12. Gilbert, S. G., and K. S. Grant-Webster. 1995. Neurobehavioral effects of developmental methylmercury exposure. *Environ. Health Perspect*. 103:135-142.

13. Grandjean, P., P. Weihe, R. F. White, F. Debes, S. Arake, K. Yokoyama, K. Murata, N. Sorensen, R. Dahl, and P. J. Jorgensen. 1997. Cognitive deficit in 7-year-old children with prenatal exposure to methylmercury. *Neurotoxicol. Teratol*. 19:417-428.

14. Harada, M. 1995. Minamata disease: methylmercury poisoning in Japan caused by environmental pollution. *Crit. Rev. Toxicol*. 25:1-24.

15. Health Canada. 2012. Canadian standards (maximum levels) for various chemical contaminants in foods. Available at: http://www.hc-sc.gc.ca/fn-an/securit/chem-chim/contaminants-guidelines-directives-eng.php. Accessed 26 February 2014.

16. Lieske, C. L., S. K. Moses, J. M. Castellin, J. Klejka, K. Hueffer, and T. M. O'Hara. 2011. Toxicokinetics of mercury in blood compartments and hair of fish-fed sled dogs. *Acta Vet. Scand*. 53:66-74.

17. National Marine Fisheries Service. 2013. Fisheries of the United States 2012: current fishery statistics. Available at: http://www.st.nmfs.noaa.gov/commercial-fisheries/fus/fus12/index. Accessed 26 February 2014.

18. National Research Council. 2000. Toxicological effects of methylmercury. National academies press, Washington, D.C.

19. Nordberg, G. F., B. A. Fowler, M. Nordberg, and L. T. Friberg (ed.). 2007. Handbook on the toxicology of metals. Academic press, Burlington, MA.

20. Oken, E., J. S. Radesky, R. O. Wright, D. C. Bellinger, C. J. Amarasiriwardena, K. P. Kleinman, H. Hu, and M. W. Gillman. 2008. Maternal fish Intake during pregnancy, blood mercury levels, and child cognition at age 3 years in a U.S. cohort. *Am. J. Epidemiol*. 167:1171-1181.

21. Pacyna, E. G., J. M. Pacyna, K. Sundseth, J. Munthe, K. Kindbom, S. Wilson, F. Steenhuisen, and P. Maxson. 2010. Global emission of mercury to the atmosphere from anthropogenic sources in 2005 and projections to 2020. *Atmos. Environ*. 44:2487-2499.

22. Randi, M. 2013. Personal communication.

23. Silbernagel, S. M., D. O. Carpenter, S. G. Gilbert, M. Gochfeld, E. Groth III, J. M. Hightower, and F. M. Schiavone. 2011. Recognizing and preventing overexposure to methylmercury from fish and seafood consumption: information for physicians. *J. Toxicol*. 2011:1-7.

24. Tremain, D. M., and D. H. Adams. 2012. Mercury in groupers and sea basses from the Gulf of Mexico: relationships with size, age, and feeding ecology. *Trans. Am. Fish. Soc*. 141:1274-1286.

25. U.S. Environmental Protection Agency. 2001. Human health criteria – methylmercury fish tissue criterion. Available at: http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/methylmercury/factsheet.cfm. Accessed 26 February 2014.

26. U.S. Environmental Protection Agency. 2007. EPA Method 7473: Mercury in solids and solutions by thermal decomposition, amalgamation, and atomic absorption spectrophotometry. Available at: http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/7473.pdf. Accessed 26 February 2014.

27. U.S. Environmental Protection Agency, Integrated Risk Information System. 2001. Methylmercury (MeHg) (CASRN 22967-92-6). Available at: http://www.epa.gov/iris/subst/0073.htm. Accessed 26 February 2014.

28. U.S. Environmental Protection Agency and U.S. Food and Drug Administration. 2004. What you need to know about mercury in fish and shellfish. Available at: http://www.fda.gov/Food/FoodborneIllnessContaminants/BuyStoreServeSafeFood/ucm110591.htm. Accessed 26 February 2014.

29. U.S. Food Drug and Administration. 2007. Compliance policy guidelines section 540.600 fish, shellfish, crustaceans and other aquatic animals – fresh, frozen or processed – methyl mercury. Available at: http://www.fda.gov/ICECI/ComplianceManuals/CompliancePolicyGuidanceManual/ucm074510.htm. Accessed 26 February 2014.

30. U.S. Food and Drug Administration. 2013. Mercury levels in commercial fish and shellfish (1990-2010). Available at: http://www.fda.gov/food/foodborneillnesscontaminants/metals/ucm115644.htm. Accessed 26 February 2014.

31. Van Walleghem, J. L. A., P. J. Blanchfield, L. E. Hrenchuk, and H. Hintelmann. 2013. Mercury elimination by a top predator, *Esox lucius. Environ. Sci. Technol*. 47:4147-4154.

32. Wente, S. P. 2004. A statistical model and national data set for partitioning fish-tissue mercury concentration variation between spatiotemporal and sample characteristic effects. U.S. Geological Survey Scientific Investigation Report 2004-5199, 15 p.

33. World Health Organization, International Program on Chemical Safety. 1990. Environmental health criteria 101: methylmercury. Available at: http://www.inchem.org/documents/ehc/ehc/ehc101.htm. Accessed 26 February 2014.

3.9. Tables and Figures

Table 3.1. Calibration equations used for each of the catalyst tubes.

	Cell 1		Cell 2	
	Calibration Equation	R^2	Calibration Equation	R^2
Catalyst 1	$A = 0.05641*C – 8.943e\text{-}4*C^2$	0.9998	$A = 0.001025*C – 2.8e\text{-}7*C^2$	1.0000
Catalyst 2	$A = 0.03586*C – 3.049e\text{-}4*C^2$	0.9999	$A = 0.001021*C – 2.1e\text{-}7*C^2$	0.9998
Catalyst 3	$A = 0.04893*C – 0.001012*C^2 + 1.352e\text{-}5*C^3$	0.9991	$A = 0.001076*C – 3.1e\text{-}7*C^2$	1.0000

“A” represents absorbance; “C” represents concentration. Each catalyst tube was calibrated after conditioning with liquid mercury standards. Calibration equations and correlation coefficients were determined by Milestone software included with the DMA-80.

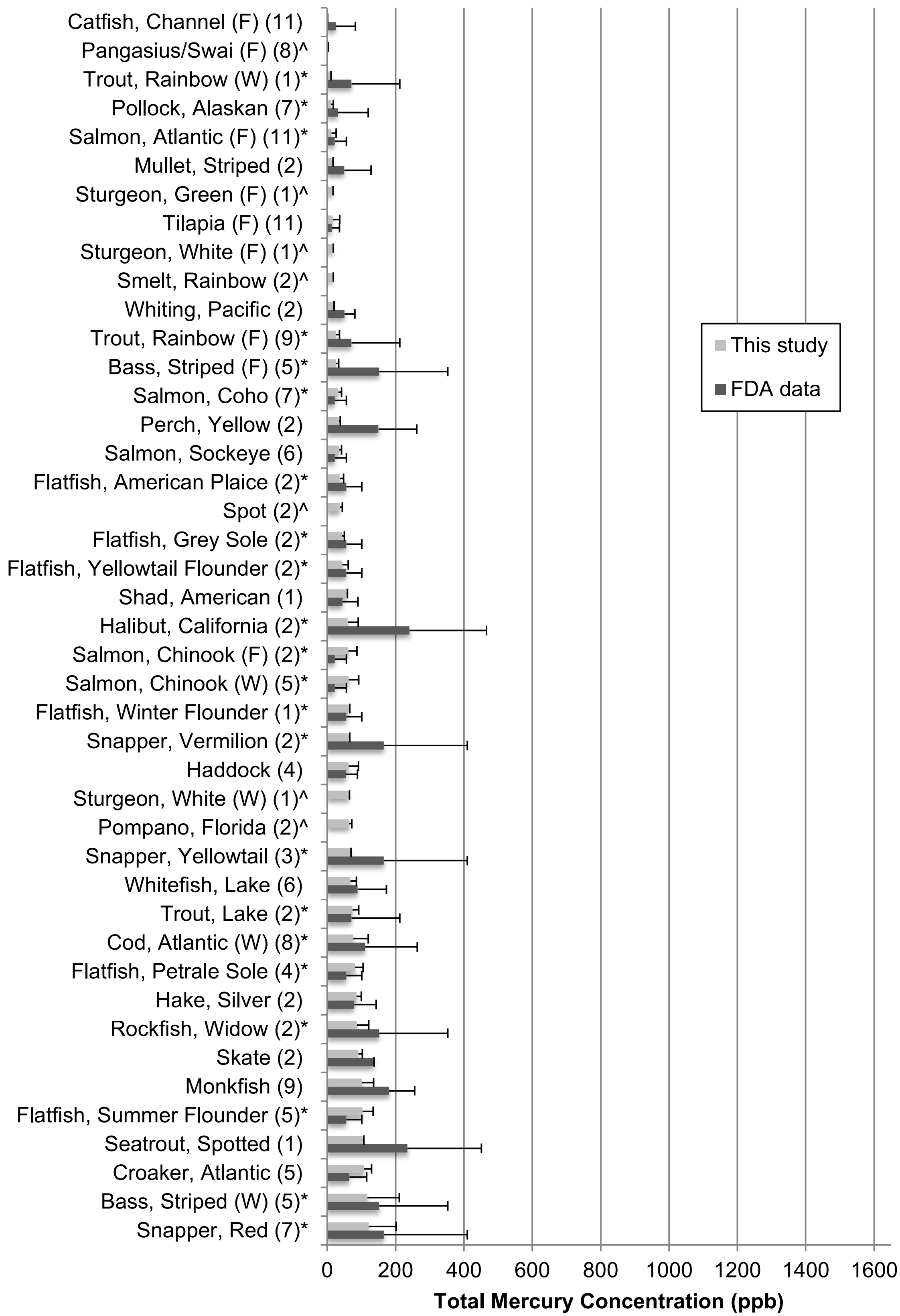
Table 3.2. Fish consumption categories for sensitive populations.

Recommended Consumption	Mercury Concentration
Up to 12 oz/week	< 123 ppb
Up to 8 oz/week	123 – 185 ppb
Up to 4 oz/week[a]	185 – 370 ppb
No consumption[a]	> 370 ppb

[a] Consumption of fish with > 185 ppb mercury is not recommended for sensitive populations, as large doses mercury may have toxic effects.

Table 3.3. Consumption advice for sensitive populations, based on results from this study.

Up to 12 oz/week	Up to 12 oz/week	Up to 12 oz/week	Up to 8 oz/week	Up to 4 oz/week	Do Not Eat
Bass, Striped (F)	*Monkfish*	*Skate*	*Cod, Atlantic (F)*	*Amberjack, Yellowtail*	*Amberjack, Greater*
Bass, Striped (W)	*Mullet, Striped*	*Smelt, Rainbow*	*Cod, Lingcod*	*Bluefish*	*Cod, Sablefish*
Catfish, Channel (F)	*Pangasius/Swai (F)*	*Snapper, Vermilion*	*Cod, Pacific*	*Flatfish, Rex Sole*	*Grouper, Gag*
Cod, Atlantic (W)	*Perch, Yellow*	*Snapper, Yellowtail*	*Flatfish, English Sole*	*Flatfish, Southern Flounder*	*Grouper, Red*
Croaker, Atlantic	*Pollock, Alaskan*	*Spot*	*Flatfish, Gulf Flounder*	*Halibut, Alaskan*	*Grouper, Yellowedge*
Flatfish, American Plaice	*Pompano, Florida*	*Sturgeon, Green (F)*	*Flatfish, Pacific Dover Sole*	*Mackerel, Spanish*	*Mackerel, King*
Flatfish, Grey Sole	*Rockfish, Widow*	*Sturgeon, White (F)*	*Grouper (unspecified)*	*Mahi Mahi*	*Roughy, Orange*
Flatfish, Petrale Sole	*Salmon, Atlantic (F)*	*Sturgeon, White (W)*	*Perch, Pacific Ocean*	*Rockfish, Brown*	*Swordfish*
Flatfish, Summer Flounder	*Salmon, Chinook (F)*	*Tilapia (F)*	*Perch, White*	*Sea Bass, Chilean*	*Tilefish (Mexico)*
Flatfish, Winter Flounder	*Salmon, Chinook (W)*	*Trout, Lake*	*Pollock, Atlantic*	*Sea Bass, White*	*Tilefish (North)*
Flatfish, Yellowtail Flounder	*Salmon, Coho*	*Trout, Rainbow (F)*	*Scup*	*Shark, Common Thresher*	*Tuna, Bluefin*
Haddock	*Salmon, Sockeye*	*Trout, Rainbow (W)*	*Sea Bass, Black*	*Shark, Spiny Dogfish*	*Wahoo*
Hake, Silver	*Seatrout, Spotted*	*Whitefish, Lake*	*Snapper, Red*	*Tuna, Albacore*	
Halibut, California	*Shad, American*	*Whiting, Pacific*		*Tuna, Yellowfin*	
				Walleye	



Catfish, Channel (F) (11)
Pangasius/Swai (F) (8)^
Trout, Rainbow (W) (1)*
Pollock, Alaskan (7)*
Salmon, Atlantic (F) (11)*
Mullet, Striped (2)
Sturgeon, Green (F) (1)^
Tilapia (F) (11)
Sturgeon, White (F) (1)^
Smelt, Rainbow (2)^
Whiting, Pacific (2)
Trout, Rainbow (F) (9)*
Bass, Striped (F) (5)*
Salmon, Coho (7)*
Perch, Yellow (2)
Salmon, Sockeye (6)
Flatfish, American Plaice (2)*
Spot (2)^
Flatfish, Grey Sole (2)*
Flatfish, Yellowtail Flounder (2)*
Shad, American (1)
Halibut, California (2)*
Salmon, Chinook (F) (2)*
Salmon, Chinook (W) (5)*
Flatfish, Winter Flounder (1)*
Snapper, Vermilion (2)*
Haddock (4)
Sturgeon, White (W) (1)^
Pompano, Florida (2)^
Snapper, Yellowtail (3)*
Whitefish, Lake (6)
Trout, Lake (2)*
Cod, Atlantic (W) (8)*
Flatfish, Petrale Sole (4)*
Hake, Silver (2)
Rockfish, Widow (2)*
Skate (2)
Monkfish (9)
Flatfish, Summer Flounder (5)*
Seatrout, Spotted (1)
Croaker, Atlantic (5)
Bass, Striped (W) (5)*
Snapper, Red (7)*
This study
FDA data
0
200
400
600
800
1000
1200
1400
1600
Total Mercury Concentration (ppb)

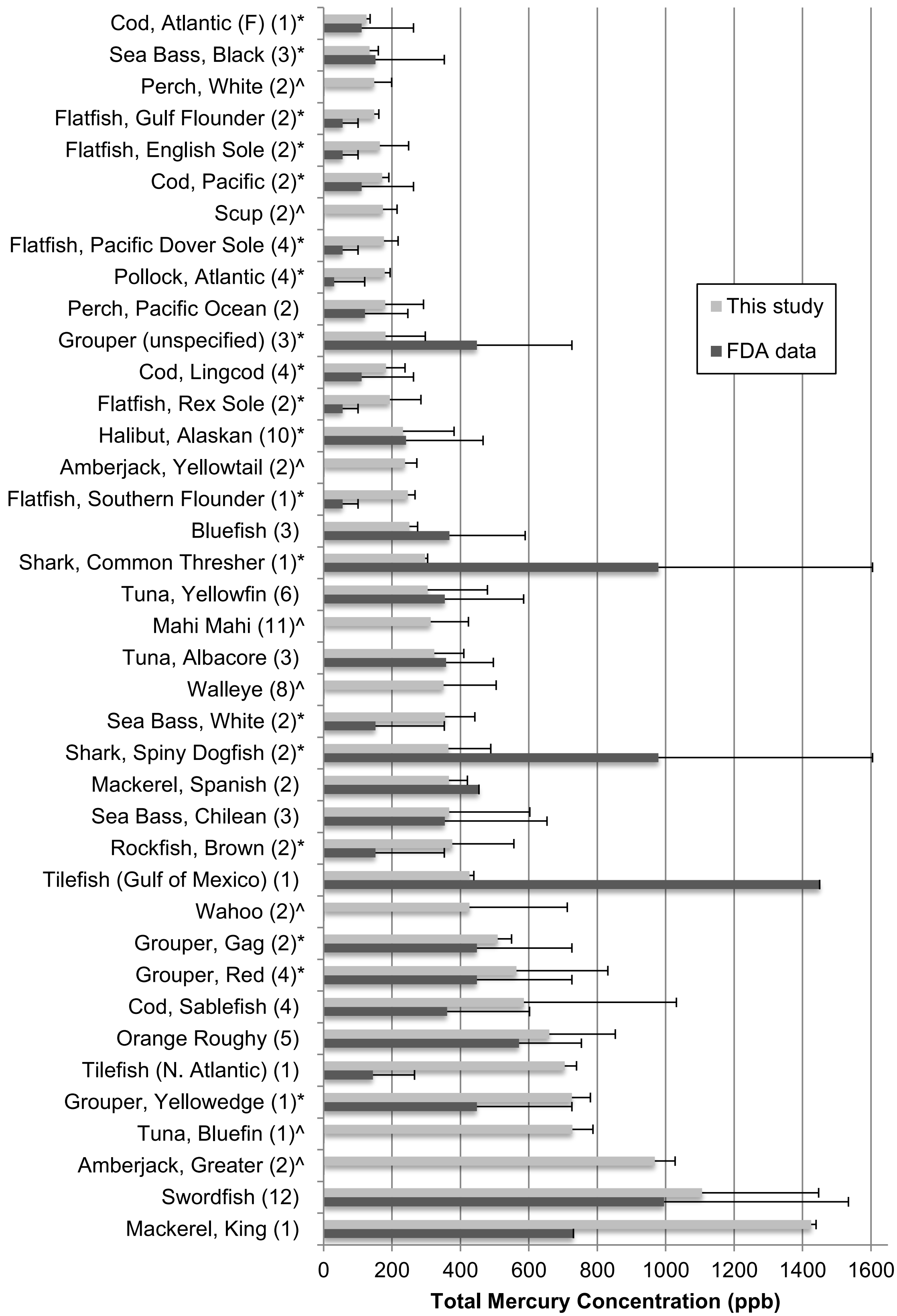

Cod, Atlantic (F) (1)*
Sea Bass, Black (3)*
Perch, White (2)^
Flatfish, Gulf Flounder (2)*
Flatfish, English Sole (2)*
Cod, Pacific (2)*
Scup (2)^
Flatfish, Pacific Dover Sole (4)*
Pollock, Atlantic (4)*
Perch, Pacific Ocean (2)
Grouper (unspecified) (3)*
Cod, Lingcod (4)*
Flatfish, Rex Sole (2)*
Halibut, Alaskan (10)*
Amberjack, Yellowtail (2)^
Flatfish, Southern Flounder (1)*
Bluefish (3)
Shark, Common Thresher (1)*
Tuna, Yellowfin (6)
Mahi Mahi (11)^
Tuna, Albacore (3)
Walleye (8)^
Sea Bass, White (2)*
Shark, Spiny Dogfish (2)*
Mackerel, Spanish (2)
Sea Bass, Chilean (3)
Rockfish, Brown (2)*
Tilefish (Gulf of Mexico) (1)
Wahoo (2)^
Grouper, Gag (2)*
Grouper, Red (4)*
Cod, Sablefish (4)
Orange Roughy (5)
Tilefish (N. Atlantic) (1)
Grouper, Yellowedge (1)*
Tuna, Bluefin (1)^
Amberjack, Greater (2)^
Swordfish (12)
Mackerel, King (1)
This study
FDA data
0
200
400
600
800
1000
1200
1400
1600
Total Mercury Concentration (ppb)

Figure 3.1. Mercury concentration in commercially-available U.S. finfish. Light grey bars represent data from the current study, while dark grey bars represent data from FDA *(30)*. Numbers in parentheses represent the number of composites (three fish each) collected for each species. (F) and (W) distinguish between farmed and wild samples; unlabeled species are wild. ^Indicates that no data are available on the FDA website. *Indicates that FDA data are not specific to the species, but is the closest approximation. For example, all flatfish species are grouped together as "flounder, plaice, or sole" on the FDA website. The current study differentiates between all species.

CHAPTER 4. CONCLUSIONS AND FUTURE DIRECTIONS

4.1. Summary of Results

The work presented in this thesis reflects the current status of the fatty acid and mercury content in commercially-available U.S. finfish and serves as a substantial addendum to the data currently available from the USDA-ARS NND[165] and FDA.[166] The data collected in this study add value to these databases by differentiating between species currently classified in categories (e.g., flatfish) rather than as individual species. For consumers, this is the most up-to-date information available on commonly consumed species and will empower them to make informed decisions regarding seafood consumption. This study also highlights the changes in commercial markets due to a burgeoning aquaculture industry and found several species with average mercury concentrations above the FDA's Action Level.[140]

4.1.1. Fatty Acid Results

The first half of this thesis assessed the lipid content in commercially-available finfish by measuring full fatty acid profiles, with a focus on EPA and DHA. Overall, results compared well to the USDA-ARS NND,[165] with large variances in fatty acid concentrations noted within and between species. EPA plus DHA content varied considerably among the "top ten" and farmed species. As these fish are widely consumed and popular among many consumers, effectively communicating these differences is essential to ensuring consumers are able to make informed seafood choices and obtain at least 1750 mg of EPA plus DHA weekly.[14] The results of this study show that only 12 of the 77 species tested will provide the recommended weekly amount of EPA plus DHA in 8 oz or less, emphasizing the need for consumption of a variety of species, with an emphasis on consuming the 12 species with higher levels of EPA plus DHA.

Despite the large differences observed in the fatty acid profiles of wild-caught fish, the fatty acid content of these species remains relatively unchanged over time, while the fatty acid profiles of farmed fish have the potential to be much more volatile. The driving force behind these fluctuations is dietary changes.[17] Wild fish have stable diets that may change slowly over time, but are not subject to the daily changes that may be incurred by farm-fed fish. Because of this, constant monitoring and updating of the fatty acid profiles of farmed species is needed. In this study, farmed fish exhibited high concentrations of SFA, MUFA, and n-6 fatty acids. These fatty acids are readily available from inexpensive sources and commonly added to fish feed as a low cost source of energy.[17] Because fish cannot endogenously synthesis EPA and DHA, they must be obtained from dietary sources. This is critically important in aquaculture environments, where the diet is controlled by farmers and higher cost marine oils are only incorporated when necessary.

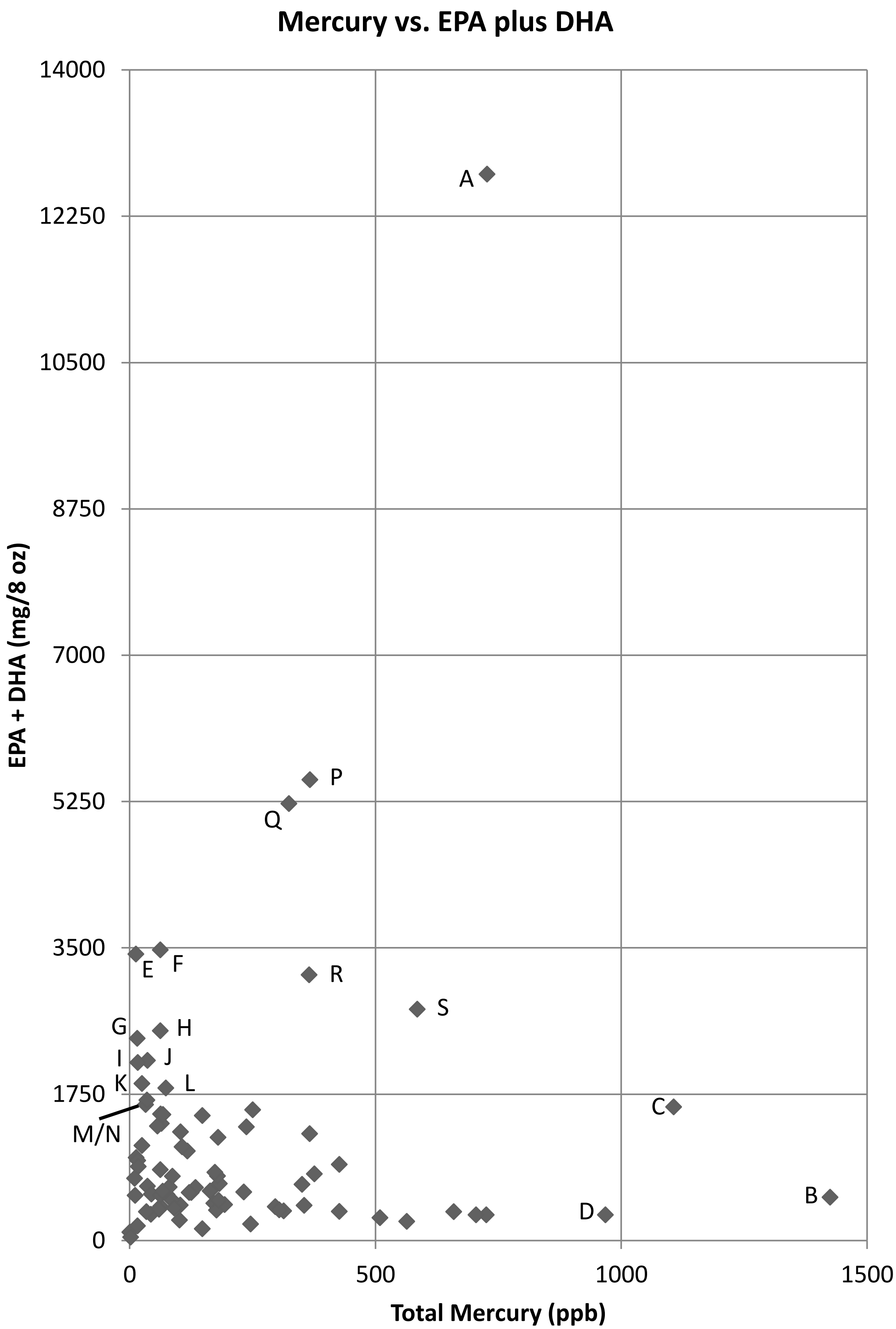
4.1.2. Mercury Results

The second half of this study measured the total mercury content of all collected fish. The results compared well to previously established values,[166] though large variances were again noted within and between species. As expected, higher mercury levels were found in the muscle tissue of predatory species, with two species exceeding the FDA's Action Level of 1000 ppb.[140] These fish may not be sold in commercial markets, though their presence in this study indicates that the FDA is not enforcing the action level and consumers are not being adequately protected from high mercury fish.

To protect sensitive populations from consuming large amounts of mercury, consumption advice was determined using the USEPA's blood mercury RfD of 0.1 μg/kg bw-d.[144] For the fish examined in this study, it was found that 50 of the 77 species analyzed contained less than 185 ppb mercury and are safe for consumers in sensitive populations to consume up to 8 oz per week, assuming a body weight of 60 kg. However, the other 27 species should be avoided, as they have higher levels of mercury and may induce developmental delays in fetuses and infants. These data will help sensitive populations increase their confidence in selecting seafood with low levels of mercury that will not pose an unnecessary risk for them or their developing children.

4.1.3. Integration of Results

Figure 4.1 illustrates the compilation of all data obtained in this study. Species that were obtained from both farmed and wild sources are shown as separate points on the graph. Most species exhibited low concentrations of both EPA plus DHA and mercury. These species are considered safe to eat, as they do not contain high levels of mercury, but they do not provide the necessary levels of EPA plus DHA in eight ounces per week either. This indicates that consumers of these species may not attain the desired health benefits associated with EPA and DHA.



Mercury vs. EPA plus DHA
EPA + DHA (mg/8 oz)
14000
12250
10500
8750
7000
5250
3500
1750
0
Total Mercury (ppb)
0
500
1000
1500
A
P
Q
E
F
R
S
G
H
I
J
K
L
M/N
C
B
D

Figure 4.1 – Total mercury content versus EPA plus DHA content in eight ounces for all species collected in this study. Each point represents the average values of total mercury content and EPA plus DHA in eight ounces for each species. Letters denote specific species of interest, as discussed in the text: A – bluefin tuna, B – king mackerel, C – swordfish, D – greater amberjack, E – farmed Atlantic salmon, F – farmed Chinook salmon, G – farmed green sturgeon, H – wild Chinook salmon, I – farmed white sturgeon, J – spot, K – farmed rainbow trout, L – lake trout, M/N – coho salmon and sockeye salmon, P – Chilean sea bass, Q – albacore tuna, R – spiny dogfish, and S – sablefish.

Several species in this study contained higher levels of EPA plus DHA, mercury, or both. Bluefin tuna (point A) contains a much higher EPA plus DHA content than all other species, though it also has a fairly high mercury concentration. Other high mercury species (points B, C, and D) would be unsafe for consumers in sensitive populations, though it is interesting to note that swordfish (point C) will almost provide the requisite EPA plus DHA in eight ounces per week. On the other hand, the species that would provide the necessary EPA plus DHA in eight ounces or less per week, while also containing low amounts of mercury, are farmed Atlantic salmon, Chinook salmon (farmed and wild), farmed sturgeon (green and white), spot, farmed rainbow trout, and lake trout (points E – L). Additionally, Chilean sea bass and albacore tuna (points P and Q, respectively) may be good options, though only four ounces of these species may be consumed by sensitive populations each week. Two other species that contained high levels of EPA plus DHA and mercury are spiny dogfish and sablefish (points R and S, respectively). These species would not be good choices for sensitive populations because the necessary amounts of EPA plus DHA cannot be obtained without exceeding the USEPA's RfD.[144]

Figure 4.1 also illustrates the differences in fatty acids between species within the same genus or family. The five salmon points on the graph (E, F, H, M, and N) are all low in mercury, but farmed salmon (E and F) have twice the EPA plus DHA content of coho and sockeye salmon (M and N). This reinforces the necessity of separating each fish “category” by individual species to properly convey clear information to consumers

4.2. Study Limitations

As with all studies, significant limitations were present in this analysis. The goal of this study was to examine fatty acids and mercury in commercially available finfish to reflect what consumers have access to in commercial U.S. markets. This methodology has significant benefits from a public health perspective, but suffers from limitations in the availability of details concerning the fish. The vendors participating in this study secured the appropriate species and provided as much background information on each fish as possible. However, vendors often obtained fish from third parties, limiting their ability to track the origin and size of each whole fish. Additionally, many fish are processed and flash frozen immediately after harvest to reduce lipid oxidation. This practice preserves the flavor and quality of the fish, but limited the data available for the samples collected in this study.

Additional limitations were present with aquaculture species, as they are grown and harvested in many geographically diverse locations around the world. Without going to the farms to gather details on the aquatic environment, contaminants present, feeding regimen, and contents of the food, it is difficult to make definitive statements about these species. Some farmed species (salmon, sturgeon, and rainbow trout) contained high levels of EPA and DHA, but the variation in lipid profiles was large. This variation is most likely due to dietary differences between the farms, though other factors, like activity levels and the density of fish in the pen, may account for a significant portion of this variability. It should also be noted that contaminants are different in each farm. Mercury and PCBs may accumulate from variations in the feed or water quality on different farms. These variables are important to consider but were not available in this study due to the constraints of only analyzing samples from commercial vendors.

4.3. Future Work

As technology continues to improve and information is increasingly made available, consumer seafood selections are increasingly fact based decisions, rather than simply preference based choices. By differentiating between species and providing details on the origin of each sample, the results of this study will enhance the information currently available to consumers, especially those in sensitive populations. With the rapid growth of aquaculture over the past decade, seafood sold in commercial markets is constantly changing to reflect the availability of species from all sources. Farm-raised fish vary widely in their fatty acid content, but all have low levels of mercury. This observation, coupled with the expectation that wild-capture seafood production will remain steady while aquaculture production continues to grow and gain market share,[17] indicates that blood mercury levels of fish consumers should decrease in coming years. This decrease may provide additional protection for sensitive populations and reduce the risk of developmental delays from methylmercury.

To gain further insights into the benefits or deficits associated with consuming each species, risk-benefit analysis should be performed. The total mercury and EPA plus DHA data obtained in this study serves as an excellent basis for such analyses. To expand the impact of this analysis, further testing for PCBs and other contaminants is needed. Currently, Alison Kleiner is measuring the concentration of 24 elements in these samples, including aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, selenium, sodium, strontium, thallium, tin, vanadium, and zinc. Most of these elements are toxic metals, but some (e.g., manganese) are beneficial micronutrients. By including the results of her current work, a more comprehensive risk-benefit analysis can be performed. This may further clarify the differences between species.

Future research in this area should examine the most effective means of communicating this information to consumers. Many tools already exist and evaluating their effectiveness in light of the data provided in this study is a necessary next step. Dr. Santerre has already begun one study to evaluate the effectiveness of a seafood wallet card. Furthermore, follow-up studies should continue to monitor the lipid profiles of farmed species, as their diets are constantly changing to maximize cost savings in competitive markets. Investigating feed formulations and finishing diets is ongoing in the aquaculture industry, but approaching the task from an academic research perspective will shed new light on the problem and may lead to optimized diet solutions. Researching the necessity of regulatory guidelines for aquaculture is another important step to ensure consumer protection. Finally, new means must be employed to enforce the FDA’s Action Level and protect consumers from purchasing and consuming fish with unsafe levels of mercury. One potential solution is the establishment of size-mercury correlations in large predatory species. This would allow regulators to rapidly determine if each fish landed is safe for sale in commercial markets based on fish size, eliminating the need for tedious and expensive mercury analyses. The research presented here serves as a stepping stone to achieving these future goals, though many steps must be taken before they can be attained.

LIST OF REFERENCES

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1. National Marine Fisheries Service. Fisheries of the United States 2012: Current fishery statistics. http://www.st.nmfs.noaa.gov/commercial-fisheries/fus/fus12/index (accessed March 10, 2014).

2. National Fisheries Institute. Top ten consumed seafoods. https://www.aboutseafood.com/about/about-seafood/top-10-consumed-seafoods (accessed March 10, 2014).

3. Morrissey, M. T. The good, the bad, and the ugly: weighing the risks and benefits of seafood consumption. *Nutr. Health* **2006**, *18*, 193-197.

4. Willett, W. C. Fish – balancing health risks and benefits. *Am. J. Prev. Med.* **2005**, *29*, 320-321.

5. Domingo, J. L.; Bocio, A.; Falco, G.; Llobet, J. M. Benefits and risks of fish consumption Part I. A quantitative analysis of the intake of omega-3 fatty acids and chemical contaminants. *Toxicology.* **2007**, *230*, 219-226.

6. Mozaffarian, D.; Rimm, E. B. Fish intake, contaminants, and human health – Evaluating the risks and the benefits. *J. Am. Med. Assoc.* **2006**, *296*, 1885-1899.

7. Smith, K. L.; Guentzel, J. L. Mercury concentrations and omega-3 fatty acids in fish and shrimp: preferential consumption for maximum health benefits. *Mar. Pollut. Bull.* **2010**, *60*, 1615-1618.

8. Oehlenschlager, J. Seafood: nutritional benefits and risk aspects. *Int. J. Vitam. Nutr. Res.* **2012**, *82*, 168-176.

9. Levenson, C. W.; Axelrad, D. M. Too much of a good thing? Update on fish consumption and mercury exposure. *Nutr. Rev.* **2006**, *64*, 139-145.

10. Sioen, I.; De Henauw, S.; Van Camp, J.; Volatier, J. L.; Leblanc, J. C. Comparison of the nutritional-toxicological conflict related to seafood consumption in different regions worldwide. *Regul. Toxicol. Pharmacol.* **2009**, *55*, 219-228.

11. U.S. Environmental Protection Agency and U.S. Food and Drug Administration. 2004. What you need to know about mercury in fish and shellfish. http://www.fda.gov/Food/FoodborneIllnessContaminants/BuyStoreServeSafeFood/ucm110591.htm (accessed Feb 26, 2014).

12. Gall, K.; Kern, S.; Morrissey, M.; Hellberg, R.; Geise, L.; Pivarnik, L.; Hick, D.; Tom, P.; Otwell, S.; Mann, H. Seafood health facts. http://seafoodhealthfacts.org/overview.php (accessed March 10, 2014).

13. Santerre, C. Fish4Health.net. http://fn.cfs.purdue.edu/fish4health/ (accessed March 10, 2014).

14. U.S. Department of Agriculture and Department of Health and Human Services. *Dietary Guidelines for Americans 2010*. http://www.cnpp.usda.gov/DGAs2010-DGACReport.htm (accessed March 10, 2014).

15. Greiner, A.; Smith, K. C.; Guallar, E. Something fishy? News media presentation of complex health issues related to fish consumption guidelines. *Public Health Nutr.* **2010**, *13*, 1786-1794.

16. Bostock, J.; McAndrew, B.; Richards, R.; Jauncey, K.; Telfer, T.; Lorenzen, K.; Little, D.; Ross, L.; Handisyde, N.; Gatward, I.; Corner, R. Aquaculture: global status and trends. *Philos. Trans. R. Soc. Lond. B. Biol. Sci.* **2010**, *365*, 2897-2912.

17. Hardy, R. W.; Lee, C. S. Aquaculture feed and seafood quality. *Bull. Fisheries Res. Agency.* **2010**, 43-50.

18. Jobling, M.; Johansen, S. J. S. Fat distribution in Atlantic salmon *Salmo salar L.* in relation to body size and feeding regime. *Aquac. Res.* **2003**, *34*, 311-316.

19. Bell, J. G.; McEvoy, J.; Tocher, D. R.; McGhee, F.; Campbell, P. J.; Sargent, J. R. Replacement of fish oil with rapeseed oil in diets of Atlantic salmon (*Salmo salar*) affects tissue lipid compositions and hepatocyte fatty acid metabolism. *J. Nutr.* **2001**, *131*, 1535-1543.

20. Code of Federal Regulations. 21 CFR 101.9. *Nutrition labeling of foods.* U.S. Government Printing Office: Washington, D.C., 2009.

21. Institute of Medicine of the National Academies. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients)*. National Academies Press: Washington, D.C., 2005.

22. Damodaran, S.; Parkin, K.; Fennema, O. R. *Fennema's Food Chemistry*. 4th edition; CRC Press: Boca Raton, FL, 2008.

23. Vannice, G.; Rasmussen, H. Position of the Academy of Nutrition and Dietetics: dietary fatty acids for healthy adults. *J. Acad. Nutr. Diet.* **2014**, *114*, 136-153.

24. Micha, R.; Mozaffarian, D. Saturated fat and cardiometabolic risk factors, coronary heart disease, stroke, and diabetes: a fresh look at the evidence. *Lipids.* **2010**, *45*, 893-905.

25. de Lorgeril, M.; Salen, P. New insights into the health effects of dietary saturated and omega-6 and omega-3 polyunsaturated fatty acids. *BMC Med.* **2012**, *10*, 50.

26. Trumbo, P. R.; Shimakawa, T. Tolerable upper intake levels for trans fat, saturated fat, and cholesterol. *Nutr. Rev.* **2011**, *69*, 270-278.

27. Hall, W. L. Dietary saturated and unsaturated fats as determinants of blood pressure and vascular function. *Nutr. Res. Rev.* **2009**, *22*, 18-38.

28. Eyre, H.; Kahn, R.; Robertson, R. M.; Clark, N. G.; Doyle, C.; Hong, Y. L.; Gansler, T.; Glynn, T.; Smith, R. A.; Taubert, K.; Thun, M. J. Preventing cancer, cardiovascular disease, and diabetes – a common agenda for the American Cancer Society, the American Diabetes Association, and the American Heart Association. *Circulation.* **2004**, *109*, 3244-3255.

29. Jakobsen, M. U.; O'Reilly, E. J.; Heitmann, B. L.; Pereira, M. A.; Balter, K.; Fraser, G. E.; Goldbourt, U.; Hallmans, G.; Knekt, P.; Liu, S. M.; Pietinen, P.; Spiegelman, D.; Stevens, J.; Virtamo, J.; Willett, W. C.; Ascherio, A. Major types of dietary fat and risk of coronary heart disease: a pooled analysis of 11 cohort studies. *Am. J. Clin. Nutr.* **2009**, *89*, 1425-1432.

30. Schwingshackl, L.; Hoffmann, G. Monounsaturated fatty acids and risk of cardiovascular disease: synopsis of the evidence available from systematic reviews and meta-analyses. *Nutrients.* **2012**, *4*, 1989-2007.

31. Gillingham, L. G.; Harris-Janz, S.; Jones, P. J. H. Dietary monounsaturated fatty acids are protective against metabolic syndrome and cardiovascular disease risk factors. *Lipids.* **2011**, *46*, 209-228.

32. Degirolamo, C.; Rudel, L. L. Dietary monounsaturated fatty acids appear not to provide cardioprotection. *Curr. Atheroscler. Rep.* **2010**, *12*, 391-396.

33. Brown, J. M.; Shelness, G. S.; Rudel, L. L. Monounsaturated fatty acids and atherosclerosis: opposing views from epidemiology and experimental animal models. *Curr. Atheroscler. Rep.* **2007**, *9*, 494-500.

34. Psaltopoulou, T.; Naska, A.; Orfanos, P.; Trichopoulos, D.; Mountokalakis, T.; Trichopoulou, A. Olive oil, the Mediterranean diet, and arterial blood pressure: the Greek European Prospective Investigation into Cancer and Nutrition (EPIC) study. *Am. J. Clin. Nutr.* **2004**, *80*, 1012-1018.

35. Carrillo, C.; Cavia, M. D.; Alonso-Torre, S. R. Antitumor effect of oleic acid; mechanisms of action; a review. *Nutrición Hospitalaria,* **2012**, *27*, 1860-1865.

36. Chajes, V.; Thiebaut, A. C. M.; Rotival, M.; Gauthier, E.; Maillard, V.; Boutron-Ruault, M. C.; Joulin, V.; Lenoir, G. M.; Clavel-Chapelon, F. Association between serum trans-monounsaturated fatty acids and breast cancer risk in the E3N-EPIC study. *Am. J. Epidemiol.* **2008**, *167*, 1312-1320.

37. Stoneham, M.; Goldacre, M.; Seagroatt, V.; Gill, L. Olive oil, diet and colorectal cancer: an ecological study and a hypothesis. *J. Epidemiol. Community Health.* **2000**, *54*, 756-760.

38. Pauwels, E. K. J. The protective effect of the Mediterranean diet: focus on cancer and cardiovascular risk. *Med. Prin. Pract.* **2010**, *20*, 103-111.

39. Mente, A.; de Koning, L.; Shannon, H. S.; Anand, S. S. A systematic review of the evidence supporting a causal link between dietary factors and coronary heart disease. *Arch. Intern. Med.* **2009**, *169*, 659-669.

40. Macquartmoulin, G.; Riboli, E.; Cornee, J.; Charnay, B.; Berthezene, P.; Day, N. Case-control study on colorectal-cancer and diet in Marseilles. *Int. J. Cancer.* **1986**, *38*, 183-191.

41. Nielsen, S. *Food Analysis*. 4th edition; Springer: New York, 2010.

42. Spiller, G. A. *Handbook of lipids in human nutrition*. CRC Press: Boca Raton, 1996.

43. Luchtman, D. W.; Song, C. Cognitive enhancement by omega-3 fatty acids from childhood to old age: findings from animal and clinical studies. *Neuropharmacol.* **2013**, *64*, 550-565.

44. Burke, P. A.; Ling, P. R.; Forse, R. A.; Bistrian, B. R. Conditionally essential fatty acid deficiencies in end-stage liver disease. *Nutrition.* **1999**, *15*, 302-304.

45. Simopoulos, A. The importance of the ratio of omega-6/omega-3 essential fatty acids. *Biomed. Pharmacother.* **2002**, *56*, 365-379.

46. Kang, J. X.; Liu, A. The role of the tissue omega-6/omega-3 fatty acid ratio in regulating tumor angiogenesis. *Cancer and Metastasis Rev.* **2013**, *32*, 201-210.

47. Komprda, T. Eicosapentaenoic and docosahexaenoic acids as inflammation-modulating and lipid homeostasis influencing nutraceuticals: a review. *Journal of Funct. Foods.* **2012**, *4*, 25-38.

48. Bradbury, J. Docosahexaenoic acid (DHA): an ancient nutrient for the modern human brain. *Nutrients.* **2011**, *3*, 529-554.

49. Calder, P. C. Long-chain fatty acids and inflammation. *Proc. Nutr. Soc.* **2012**, *71*, 284-289.

50. Russo, G. Dietary n-6 and n-3 polyunsaturated fatty acids: from biochemistry to clinical implications in cardiovascular prevention. *Biomed. Pharmacol.* **2009**, *77*, 937-946.

51. Shahidi, F.; Miraliakbari, H. Omega-3 (n-3) fatty acids in health and disease: part 1 – cardiovascular disease and cancer. *J. Med. Food.* **2004**, *7*, 387-401.

52. Fleith, M.; Clandinin, M. Dietary PUFA for preterm and term infants: review of clinical studies. *Crit. Rev. Food Sci. Nutr.* **2005**, *45*, 205-229.

53. Birch, E. E.; Hoffman, D. R.; Uauy, R.; Birch, D. G.; Prestidge, C. Visual acuity and the essentiality of docosahexaenoic acid and arachidonic acid in the diet of term infants. *Pediatr. Res.* **1998**, *44*, 201-209.

54. National Cancer Institute. Food sources of linoleic acid (PFA 18:2), listed in descending order by percentages of their contribution to intake, based on data from the National Health and Nutrition Examination Survey 2005-2006. http://appliedresearch.cancer.gov/diet/foodsources/fatty_acids/table3.html (accessed March 15, 2014).

55. National Cancer Institute. Food sources of alpha-linolenic acid (PFA 18:3), listed in descending order by percentages of their contribution to intake, based on data from the National Health and Nutrition Examination Survey 2005-2006. http://appliedresearch.cancer.gov/diet/foodsources/fatty_acids/table6.html (accessed March 15, 2014).

56. Simopoulos, A. P. Omega-3 fatty acids in inflammation and autoimmune diseases. *J. Am. Coll. Nutr.* **2002**, *21*, 495-505.

57. Ross, R. Mechanisms of disease – atherosclerosis – an inflammatory disease. *New Eng. J. Med.* **1999**, *340*, 115-126.

58. Hayashi, N.; Tashiro, T.; Yamamori, H.; Takagi, K.; Morishima, Y.; Otsubo, Y.; Sugiura, T.; Furukawa, K.; Nitta, H.; Nakajima, N.; Suzuki, N.; Ito, I. Effects of intravenous omega-3 and omega-6 fat emulsion on cytokine production and delayed type hypersensitivity in burned rats receiving total parenteral nutrition. *J. Parenter. Enteral Nutr.* **1998**, *22*, 363-367.

59. Castell, J. V.; Gomezlechon, M. J.; David, M.; Andus, T.; Geiger, T.; Trullenque, R.; Fabra, R.; Heinrich, P. C. Interleukin-6 is the major regulator of acute phase protein-synthesis in adult human hepatocytes. *Febs Letters.* **1989**, *242*, 237-239.

60. Woods, A.; Brull, D. J.; Humphries, S. E.; Montgomery, H. E. Genetics of inflammation and risk of coronary artery disease: the central role of interleukin-6. *Eur. Heart J.* **2000**, *21*, 1574-1583.

61. Wang, D. Z.; Dubois, R. N. Eicosanoids and cancer. *Nat. Rev. Cancer.* **2010**, *10*, 181-193.

62. Birch, E. E.; Garfield, S.; Hoffman, D. R.; Uauy, R.; Birch, D. G. A randomized controlled trial of early dietary supply of long-chain polyunsaturated fatty acids and mental development in term infants. *Dev. Med. Child Neurol.* **2000**, *42*, 174-181.

63. Fukaya, T.; Gondaira, T.; Kashiyae, Y.; Kotani, S.; Ishikura, Y.; Fujikawa, S.; Kiso, Y.; Sakakibara, M. Arachidonic acid preserves hippocampal neuron membrane fluidity in senescent rats. *Neurobiol. Aging.* **2007**, *28*, 1179-1186.

64. Wang, Z.; Liang, C.; Li, G.; Yu, C.; Yin, M. Neuroprotective effects of arachidonic acid against oxidative stress on rat hippocampal slices. *Chem-Biol. Interact.* **2006**, *163*, 207-217.

65. Rapoport, S. Arachidonic acid and the brain. *J. Nutr.* **2008**, *138*, 2515-2520.

66. Kotani, S.; Nakazawa, H.; Tokimasa, T.; Akimoto, K.; Kawashima, H.; Toyoda-Ono, Y.; Kiso, Y.; Okaicki, H.; Sakakibara, M. Synaptic plasticity preserved with arachidonic acid diet in aged rats. *Neurosci. Res.* **2003**, *46*, 453-461.

67. Esposito, G.; Giovacchini, G.; Liow, J.; Bhattachariee, A.; Greenstein, D.; Schapiro, M.; Hallett, M.; Herscovitch, P.; Eckelman, W.; Carson, R.; Rapoport, S. Imaging neuroinflammation in Alzheimer Disease with radiolabeled arachidonic acid and PET. *J. Nucl. Med.* **2008**, *49*, 1414-1421.

68. Kim, H. W.; Rapoport, S. I.; Rao, J. S., Altered arachidonic acid cascade enzymes in postmortem brain from bipolar disorder patients. *Mol. Psychiatry* **2011**, *16*, 419-428.

69. Maillard, V.; Bougnoux, P.; Ferrari, P.; Jourdan, M. L.; Pinault, M.; Lavillonniere, F.; Body, G.; Le Floch, O.; Chajes, V. N-3 and n-6 fatty acids in breast adipose tissue and relative risk of breast cancer in a case-control study in Tours, France. *Int. J. Cancer* **2002**, *98*, 78-83.

70. Leitzmann, M. F.; Stampfer, M. J.; Michaud, D. S.; Augustsson, K.; Colditz, G. C.; Willett, W. C.; Giovannucci, E. L. Dietary intake of n-3 and n-6 fatty acids and the risk of prostate cancer. *Am. J. Clin. Nutr.* **2004**, *80*, 204-216.

71. Hall, M. N.; Campos, H.; Li, H. J.; Sesso, H. D.; Stampfer, M. J.; Willett, W. C.; Ma, J. Blood levels of long-chain polyunsaturated fatty acids, aspirin, and the risk of colorectal cancer. *Cancer Epidemiol. Biomark. Prev.* **2007**, *16*, 314-321.

72. Depner, C. M.; Traber, M. G.; Bobe, G.; Kensicki, E.; Bohren, K. M.; Milne, G.; Jump, D. B. A metabolomic analysis of omega-3 fatty acid-mediated attenuation of western diet-induced nonalcoholic steatohepatitis in LDLR-/- Mice. *PLoS One.* **2013**, *8* (12), e83756.

73. Youdim, K. A.; Martin, A.; Joseph, J. A. Essential fatty acids and the brain: possible health implications. *Int. J. Dev. Neurosci.* **2000**, *18*, 383-399.

74. Gould, J. F.; Smithers, L. G.; Makrides, M. The effect of maternal omega-3 (n-3) LCPUFA supplementation during pregnancy on early childhood cognitive and visual development: a systematic review and meta-analysis of randomized controlled trials. *Am. J. Clin. Nutr.* **2013**, *97*, 531-544.

75. Wainwright, P. E.; Colombo, J. Nutrition and the development of cognitive functions: interpretation of behavioral studies in animals and human infants. *Am. J. Clin. Nutr.* **2006**, *84*, 961-970.

76. Mulder, K. A.; King, D. J.; Innis, S. M. Omega-3 fatty acid deficiency in infants before birth identified using a randomized trial of maternal DHA supplementation in pregnancy. *PLoS One.* **2014**, *9* (1), e83764.

77. Colombo, J.; Carlson, S. E.; Cheatham, C. L.; Shaddy, D. J.; Kerling, E. H.; Thodosoff, J. M.; Gustafson, K. M.; Brez, C. Long-term effects of LCPUFA supplementation on childhood cognitive outcomes. *Am. J. Clin. Nutr.* **2013**, *98*, 403-412.

78. Tuzun, F.; Kumral, A.; Ozbal, S.; Dilek, M.; Tugyan, K.; Duman, N.; Ozkan, H. Maternal prenatal omega-3 fatty acid supplementation attenuates hyperoxia-induced apoptosis in the developing rat brain. *Int. J. Dev. Neurosci.* **2012**, *30*, 315-323.

79. Frisardi, V.; Panza, F.; Seripa, D.; Farooqui, T.; Farooqui, A. A. Glycerophospholipids and glycerophospholipid-derived lipid mediators: a complex meshwork in Alzheimer's Disease pathology. *Prog. Lipid Res.* **2011**, *50*, 313-330.

80. Crupi, R.; Marino, A.; Cuzzocrea, S. N-3 fatty acids: role in neurogenesis and neuroplasticity. *Curr. Med. Chem.* **2013**, *20*, 2953-2963.

81. Swanson, D.; Block, R.; Mousa, S. A. Omega-3 fatty acids EPA and DHA: health benefits throughout life. *Adv. Nutr.* **2012**, *3*, 1-7.

82. Prolla, T. A.; Mattson, M. P. Molecular mechanisms of brain aging and neurodegenerative disorders: lessons from dietary restriction. *Trends Neurosci.* **2001**, *24*, S21-S31.

83. Dacks, P. A.; Shineman, D. W.; Fillit, H. M. Current evidence for the clinical use of long-chain polyunsaturated n-3 fatty acids to prevent age-related cognitive decline and Alzheimer's Disease. *J. Nutr. Health Aging.* **2013**, *17*, 240-251.

84. Dyall, S. C.; Michael-Titus, A. T. Neurological benefits of omega-3 fatty acids. *Neuromolecular Med.* **2008**, *10*, 219-235.

85. Wolf, P. A. Contributions of the Framingham Heart Study to stroke and dementia epidemiologic research at 60 years. *Arch. Neurol.* **2012**, *69*, 567-571.

86. Schaefer, E. J.; Bongard, V.; Beiser, A. S.; Lamon-Fava, S.; Robins, S. J.; Au, R.; Tucker, K. L.; Kyle, D. J.; Wilson, P. W. F.; Wolf, P. A. Plasma phosphatidylcholine docosahexaenoic acid content and risk of dementia and Alzheimer Disease – The Framingham Heart Study. *Arch. Neurol.* **2006**, *63*, 1545-1550.

87. van Himbergen, T. M.; Beiser, A. S.; Ai, M.; Seshadri, S.; Otokozawa, S.; Au, R.; Thongtang, N.; Wolf, P. A.; Schaefer, E. J. Biomarkers for insulin resistance and inflammation and the risk for all-cause dementia and Alzheimer Disease results from the Framingham Heart Study. *Arch. Neurol.* **2012**, *69*, 594-600.

88. Cunnane, S. C.; Chouinard-Watkins, R.; Castellano, C. A.; Barberger-Gateau, P. Docosahexaenoic acid homeostasis, brain aging and Alzheimer's Disease: can we reconcile the evidence? *Prostaglandins Leukot. Essent. Fatty Acids.* **2013**, *88*, 61-70.

89. Phillips, M. A.; Childs, C. E.; Calder, P. C.; Rogers, P. J. Lower omega-3 fatty acid intake and status are associated with poorer cognitive function in older age: a comparison of individuals with and without cognitive impairment and Alzheimer's Disease. *Nutr. Neurosci.* **2012**, *15*, 271-277.

90. Cederholm, T.; Salem, N.; Palmblad, J. Omega-3 fatty acids in the prevention of cognitive decline in humans. *Adv. Nutr.* **2013**, *4*, 672-676.

91. Tan, Z. S.; Harris, W. S.; Beiser, A. S.; Au, R.; Himali, J. J.; Debette, S.; Pikula, A.; DeCarli, C.; Wolf, P. A.; Vasan, R. S.; Robins, S. J.; Seshadri, S. Red blood cell omega-3 fatty acid levels and markers of accelerated brain aging. *Neurology.* **2012**, *78*, 658-664.

92. Viswanathan, A.; Rocca, W. A.; Tzourio, C. Vascular risk factors and dementia how to move forward? *Neurology.* **2009**, *72*, 368-374.

93. Uauy, R.; Hoffman, D. R.; Peirano, P.; Birch, D. G.; Birch, E. E. Essential fatty acids in visual and brain development. *Lipids.* **2001**, *36*, 885-895.

94. Birch, E. E.; Hoffman, D. R.; Castaneda, Y. S.; Fawcett, S. L.; Birch, D. G.; Uauy, R. D. A randomized controlled trial of long-chain polyunsaturated fatty acid supplementation of formula in term infants after weaning at 6 weeks of age. *Am. J. Clin. Nutr.* **2002**, *75*, 570-580.

95. Birch, E. E.; Carlson, S. E.; Hoffman, D. R.; Fitzgerald-Gustafson, K. M.; Fu, V. L. N.; Drover, J. R.; Castaneda, Y. S.; Minns, L.; Wheaton, D. K. H.; Mundy, D.; Marunycz, J.; Diersen-Schade, D. A. The DIAMOND (DHA Intake And Measurement Of Neural Development) study: a double-masked, randomized controlled clinical trial of the maturation of infant visual acuity as a function of the dietary level of docosahexaenoic acid. *Am. J. Clin. Nutr.* **2010**, *91*, 848-859.

96. Qawasmi, A.; Landeros-Weisenberger, A.; Bloch, M. H. Meta-analysis of LCPUFA supplementation of infant formula and visual acuity. *Pediatrics.* **2013**, *131*, E262-E272.

97. Zicker, S. C.; Jewell, D. E.; Yamka, R. M.; Milgram, N. W. Evaluation of cognitive learning, memory, psychomotor, immunologic, and retinal functions in healthy puppies fed foods fortified with docosahexaenoic acid-rich fish oil from 8 to 52 weeks of age. *J. Am. Vet. Med. Assoc.* **2012**, *241*, 583-594.

98. Sinclair, H. Deficiency of essential fatty acids and atherosclerosis, etcetera. *Lancet.* **1956**, *267*, 381-383.

99. Bang, H.; Dyerberg, J.; Nielsen, A. Plasma lipid and lipoprotein pattern in Greenlandic west-coast Eskimos. *Lancet.* **1971**, *297*, 1143-1146.

100. Dyerberg, J.; Bang, H. O.; Hjorne, N. Fatty-acid composition of plasma-lipids in Greenland Eskimos. *Am. J. Clin. Nutr.* **1975**, *28*, 958-966.

101. Menotti, A.; Kromhout, D.; Blackburn, H.; Fidanza, F.; Buzina, R.; Nissinen, A. Food intake patterns and 25-year mortality from coronary heart disease: cross-cultural correlations in the Seven Countries Study. *Eur. J. Epidemiol.* **1999**, *15*, 507-515.

102. Daviglus, M. L.; Stamler, J.; Orencia, A. J.; Dyer, A. R.; Liu, K.; Greenland, P.; Walsh, M. K.; Morris, D.; Shekelle, R. B. Fish consumption and the 30-year risk of fatal myocardial infarction. *New Eng. J. Med.* **1997**, *336*, 1046-1053.

103. Otto, M. C. D.; Wu, J. H. Y.; Baylin, A.; Vaidya, D.; Rich, S. S.; Tsai, M. Y.; Jacobs, D. R.; Mozaffarian, D. Circulating and dietary omega-3 and omega-6 polyunsaturated fatty acids and incidence of CVD in the multi-ethnic study of atherosclerosis. *J. Am. Heart Assoc.* **2013**, *2* (6).

104. Mozaffarian, D.; Lemaitre, R. N.; King, I. B.; Song, X. L.; Huang, H. Y.; Sacks, F. M.; Rimm, E. B.; Wang, M. L.; Siscovick, D. S. Plasma phospholipid long-chain omega-3 fatty acids and total and cause-specific mortality in older adults a cohort study. *Ann. Int. Med.* **2013**, *158*, 515-525.

105. Nozue, T.; Yamamoto, S.; Tohyama, S.; Fukui, K.; Umezawa, S.; Onishi, Y.; Kunishima, T.; Sato, A.; Nozato, T.; Miyake, S.; Takeyama, Y.; Morino, Y.; Yamauchi, T.; Muramatsu, T.; Hibi, K.; Terashima, M.; Michishita, I. Effects of serum n-3 to n-6 polyunsaturated fatty acids ratios on coronary atherosclerosis in statin-treated patients with coronary artery disease. *Am. J. Cardiol.* **2013**, *111*, 6-11.

106. Calder, P. C.; Yaqoob, P. Marine omega-3 fatty acids and coronary heart disease. *Curr. Opin. Cardiol.* **2012**, *27*, 412-419.

107. Harada, M. Minamata disease: methylmercury poisoning in Japan caused by environmental pollution. *Crit. Rev. Tox.* **1995**, *25*, 1-24.

108. Harada, M. Minamata disease: organic mercury poisoning caused by ingestion of contaminated fish. *Adverse Effects of Food*. Plenum Press: New York, 1982.

109. Harada, M. Congenital Minamata disease: intrauterine methylmercury poisoning. *Teratology.* **1978**, *18*, 285-288.

110. Bakir, F.; Damluji, S.; Amin-Zaki, L.; Murtadha, M.; Khalidi, A.; Al-Rawi, N.; Tikriti, S.; Dhahir, H.; Clarkson, T.; Smith, J.; Doherty, R. Methylmercury poisoning in Iraq. *Science.* **1973**, *181*, 230-241.

111. Smith, J.; Farris, F.; Von Burg, R. Chemical type of mercury in patients in the outbreak of organomercury poisoning in Iraq. *Bull. World Health Org.* **1976**, *53*, 61-63.

112. Al-Damluji, S. Intoxication due to alkylmercury-treated seed – 1971-72 outbreak in Iraq: clinical aspects. *Bull. World Health Org.* **1976**, *53*, 65-81.

113. Amin-Zaki, L.; Elhassani, S.; Majeed, M.; Clarkson, T.; Doherty, R.; Greenwood, M. Intra-uterine methylmercury poisoning in Iraq. *Pediatrics.* **1974**, *54*, 587-595.

114. Amin-Zaki, L.; Majeed, M.; Elhassani, S.; Clarkson, T.; Greenwood, M.; Doherty, R. Prenatal methylmercury poisoning. Clinical observations over five years. *Am. J. Dis. Child.* **1979**, *133*, 172-177.

115. Plessi, M.; Bertelli, D.; Monzani, A. Mercury and selenium content in selected seafood. *J. Food Comp. Anal.* **2001**, *14*, 461-467.

116. National Research Council. *Toxicological Effects of Methylmercury*. The National Academies Press: 2000.

117. Weihe, P.; Grandjean, P.; Debes, F.; White, R. Health implications for Faroe Islanders of heavy metals and PCBs from pilot whales. *Sci. Tot. Environ.* **1996**, *186*, 141-148.

118. Julshamn, K.; Andersen, A.; Ringdal, O.; Morkore, J. Trace elements intake in the Faroe Islands. I. Element levels in edible parts of pilot whales (*Globicephalus meleanus*). *Sci. Tot. Environ.* **1987**, *65*, 53-62.

119. Grandjean, P.; Weihe, P.; Jorgensen, P.; Clarkson, T.; Cernichiari, E.; Videro, T. Impact of maternal seafood diet on fetal exposure to mercury, selenium, and lead. *Arch. Environ. Health.* **1992**, *47*, 185-195.

120. Grandjean, P.; Weihe, P.; White, R.; Debes, F.; Arake, S.; Yokoyama, K.; Murata, K.; Sorensen, N.; Dahl, R.; Jorgensen, P. Cognitive deficit in 7-year-old children with prenatal exposure to methylmercury. *Neurotoxicol. Teratol.* **1997**, *19*, 417-428.

121. Debes, F.; Budtz-Jorgensen, E.; Weihe, P.; White, R.; Grandjean, P. Impact of prenatal methylmercury exposure on neurobehavioral function at age 14 years. *Neurotoxicol. Teratol.* **2006**, *28*, 363-375.

122. Davidson, P.; Myers, G.; Cox, C.; Axtell, C.; Shamlaye, C.; Sloane-Reeves, J.; Cernichiari, E.; Needham, L.; Choi, A.; Wang, Y.; Berlin, M.; Clarkson, T. Effects of prenatal and postnatal methylmercury exposure from fish consumption on neurodevelopment. *J. Am. Med. Assoc.* **1998**, *280*, 701-707.

123. Davidson, P.; Myers, G.; Cox, C.; Wilding, G.; Shamlaye, C.; Huang, L.; Cernichiari, E.; Sloane-Reeves, J.; Palumbo, D.; Clarkson, T. Methylmercury and neurodevelopment: longitudinal analysis of the Seychelles child development cohort. *Neurotoxicol. Teratol.* **2006**, *28*, 529-535.

124. Oehme, M.; Schlabach, M.; Kallenborn, R.; Haugen, J. Sources and pathways of persistent polychlorinated pollutants to remote areas of the North Atlantic and levels in the marine food chain: a research update. *Sci. Tot. Environ.* **1996**, *186*, 13-24.

125. Vetter, W.; Luckas, B.; Heidemann, G.; Skirnisson, K. Organochlorine residues in marine mammals from the northern hemisphere – a consideration of the composition of organochlorine residues in the blubber of marine mammals. *Sci. Tot. Environ.* **1996**, *186*, 29-39.

126. Pacyna, E.; Pacyna, J.; Sundseth, K.; Munthe, J.; Kindbom, K.; Wilson, S.; Steenhuisen, F.; Maxson, P. Global emission of mercury to the atmosphere from anthropogenic sources in 2005 and projections to 2020. *Atmos. Environ.* **2010**, *44*, 2487-2499.

127. Nordberg, G.; Fowler, B.; Nordberg, M.; Friberg, L., Eds. *Handbook on the Toxicology of Metals*. 3rd ed.; Academic Press: Burlington, MA, 2007.

128. Clarkson, T. W.; Magos, L. The toxicology of mercury and its chemical compounds. *Crit. Rev. Toxicol.* **2006**, *36*, 609-662.

129. Van Walleghem, J.; Blanchfield, P.; Hrenchuk, L.; Hintelmann, H. Mercury elimination by a top predator, *Esox lucius*. *Environ. Sci. Technol.* **2013**, *47*, 4147-4154.

130. Lieske, C.; Moses, S.; Castellin, J.; Klejka, J.; Hueffer, K.; O'Hara, T. Toxicokinetics of mercury in blood compartments and hair of fish-fed sled dogs. *Acta Vet. Scand.* **2011**, *53*, 66-74.

131. Casarett, L.; Doull, J. *Toxicology: The Basic Science of Poisons*. 8th ed.; McGraw Hill: New York, 2013.

132. Nierenberg, D.; Nordgren, R.; Chang, M.; Siegler, R.; Blayney, M.; Hochberg, F.; Toribara, T.; Cernichiari, E.; Clarkson, T. Delayed cerebellar disease and death after accidental exposure to dimethylmercury. *New Eng. J. Med.* **1998**, *338*, 1672-1676.

133. Wagemann, R.; Trebacz, E.; Hunt, R.; Boila, G. Percent methylmercury and organic mercury in tissues of marine mammals and fish using different experimental and calculation methods. *Environ. Toxicol. Chem.* **1997**, *16*, 1859-1866.

134. World Health Organization. Mercury: training for health care providers. www.who.int/ceh/capacity/Mercury.pdf (accessed Feb 24, 2014).

135. Aberg, B.; Ekman, L.; Falk, R.; Greitz, U.; Persson, G.; Snihs, J. O. Metabolism of methyl mercury (^{203}Hg) compounds in man. *Arch. Environ. Health.* **1969**, *19*, 478-484.

136. Eto, K. Pathology of Minamata disease. *Toxicol. Pathol.* **1997**, *25*, 614-623.

137. Eto, K.; Tokunaga, H.; Nagashima, K.; Takeuchi, T. An autopsy case of Minamata disease (methylmercury poisoning) – pathological viewpoints of peripheral nerves. *Toxicol. Pathol.* **2002**, *30*, 714-722.

138. Eto, K.; Marumoto, M.; Takeya, M. The pathology of methylmercury poisoning (Minamata disease). *Neuropathology.* **2010**, *30*, 471-479.

139. Ballatori, N.; Gatmaitan, Z.; Truong, A. Impaired biliary excretion and whole body elimination of methylmercury in rats with congenital defect in biliary glutathione excretion. *Hepatology.* **1995**, *22*, 1469-1473.

140. U.S. Food and Drug Administration. CPG Sec. 540.600 Fish, Shellfish, Crustaceans and other Aquatic Animals – Fresh, Frozen or Processed – Methyl Mercury. http://www.fda.gov/ICECI/ComplianceManuals/CompliancePolicyGuidanceManual/ucm074510.htm (accessed Feb 26, 2014).

141. Sivas, D.; Tarbox, B.; Kilduff, C. Citizen petition seeking FDA rulemaking for labeling and point of sale advisories concerning mercury in seafood to minimize methylmercury exposure to women of childbearing age and children. 2011. FDA-2011-P-0484, 39 pp.

142. U.S. Food and Drug Administration and Department of Health and Human Services. FDA/CFSAN response to GotMercury a project of the Turtle Island Restoration (TIRN), and the Center for Biological Diversity (CBD) (Mills Legal and Environmental Law Clinic) – petition denial. 2013. FDA-2011-P-0484-0005, 25 pp.

143. Cladis, D.; Kleiner, A.; Santerre, C., Mercury content in commercially-available finfish in the U.S. *J. Food Prot.* **2014**, *accepted for publication*.

144. U.S. Environmental Protection Agency, Integrated Risk Information System. Methylmercury (MeHg) (CASRN 22967-92-6). http://www.epa.gov/iris/subst/0073.htm. (accessed Feb 26, 2014).

145. Kjellstrom, T.; Kennedy, P.; Wallis, S.; Stewart, A.; Friberg, L.; Lind, B. *Physical and mental development of children with prenatal exposure to mercury from fish: stage 2, interviews and psychological tests at age 6. Report 3642*. National Swedish Environmental Protection Board: Solna, Sweden, 1989.

146. U.S. Environmental Protection Agency. Human health criteria – methylmercury fish tissue criterion. http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/methylmercury/factsheet.cfm. (accessed Feb 26, 2014).

147. Sato, R.; Li, G.; Shaha, S. Antepartum seafood consumption and mercury levels in newborn cord blood. *Am. J. Obstet. Gynecol.* **2006**, *194*, 1683-1688.

148. Groth III, E. Ranking the contributions of commercial fish and shellfish varieties to mercury exposure in the United States: implications for risk communication. *Environ. Res.* **2010**, *110*, 226-236.

149. U.S. Environmental Protection Agency. Trends in blood mercury concentration and fish consumption among U.S. women of childbearing age NHANES, 1999-2010. http://water.epa.gov/scitech/swguidance/fishshellfish/fishadvisories/upload/Trends-in-Blood-Mercury-Concentrations-and-Fish-Consumption-Among-U-S-Women-of-Childbearing-Age-NHANES-1999-2010.pdf (accessed Feb 24, 2014).

150. Godfray, H. C. J.; Beddington, J. R.; Crute, I. R.; Haddad, L.; Lawrence, D.; Muir, J. F.; Pretty, J.; Robinson, S.; Thomas, S. M.; Toulmin, C. Food security: the challenge of feeding 9 billion people. *Science.* **2010**, *327*, 812-818.

151. Dickey, A.; Brown, B. Laboratory analysis comparison: mercury testing in fish tissue samples. http://www.deq.utah.gov/Issues/Mercury/docs/hdocs/092806_Hg_lab_comparison.pdf (accessed March 26, 2014).

152. U.S. Environmental Protection Agency. EPA Method 7473: Mercury in solids and solutions by thermal decomposition, amalgamation, and atomic absorption spectrophotometry. http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/7473.pdf (accessed Feb 24, 2014).

153. Gao, Y.; Shi, Z. M.; Long, Z.; Wu, P.; Zheng, C. B.; Hou, X. D. Determination and speciation of mercury in environmental and biological samples by analytical atomic spectrometry. *Microchem. J.* **2012**, *103*, 1-14.

154. Hatch, W. R.; Ott, W. L. Determination of sub-microgram quantities of mercury by atomic absorption spectrophotometry. *Anal. Chem.* **1968**, *40*, 2085-2087.

155. Shrader, D.; Hobbins, W. *The determination of mercury by cold vapor atomic absorption. AA: instruments at work*. Document Number AA-32. 1983, 5 pp.

156. Helsby, C. A. Development and application of cold-vapor techniques for determination of mercury in biological-materials. *Mikrochim. Acta* **1976**, *1*, 307-320.

157. Matusiewicz, H.; Stanisz, E. Evaluation of high pressure oxygen microwave-assisted wet decomposition for the determination of mercury by CVAAS utilizing UV-induced reduction. *Microchem. J.* **2010**, *95*, 268-273.

158. Milestone, Inc. The DMA-80's history. http://www.milestonesci.com/direct-mercury-analyzer/dma80-history.html. (accessed March 8, 2014).

159. Boylan, H. M.; Richter, R. C.; Kingston, H. M.; Ricotta, A. Rapid mercury analysis for the field: method development and application to natural gas utility sites. *Water Air and Soil Pollut.* **2001**, *127*, 255-270.

160. Milestone, Inc. DMA-80 Operator Manual. 2009.

161. Milestone Inc. DMA-80 Principles of Operation. http://www.milestonesci.com/product-menu/mercury/dma80-overview/dma80-principles.html (accessed July 10, 2013).

162. Butala, S. J.; Scanlan, L. P.; Chaudhuri, S. N. A detailed study of thermal decomposition, amalgamation/atomic absorption spectrophotometry methodology for the quantitative analysis of mercury in fish and hair. *J. Food Prot.* **2006**, *69*, 2720-2728.

163. Butala, S. J.; Scanlan, L. P.; Chaudhuri, S. N.; Perry, D. D.; Taylor, R. J. Interlaboratory bias in the determination of mercury concentrations in commercially available fish utilizing thermal decomposition amalgamation/ atomic absorption apectrophotometry. *J. Food Prot.* **2007**, *70*, 2422-2425.

164. Haynes, S.; Gragg, R. D.; Johnson, E.; Robinson, L.; Orazio, C. E. An evaluation of a reagentless method for the determination of total mercury in aquatic life. *Water Air Soil Pollut.* **2006**, *172*, 359-374.

165. U.S. Department of Agriculture – Agricultural Research Service. National nutrient database. http://ndb.nal.usda.gov/ (accessed March 12, 2014).

166. U.S. Food and Drug Administration. Mercury levels in commercial fish and shellfish (1990-2010) http://www.fda.gov/food/foodborneillnesscontaminants/metals/ucm115644.htm, 2013 (accessed Feb 26, 2014).

APPENDIX

APPENDIX

Striped Bass (Morone Saxatilis) **Sample No. MA2013b10**

Vendor: ______________________________

Supplier: ______________________________

Wild-capture _____________ Farmed-raised _____________

Origin: Country _____________________________________

Body of water _____________________________________

Date harvested/captured (if known): ________________

Date shipped to Purdue: _______________

Were fish previously frozen? _____________

Additional information: ______________________________

Fish #1: Weight of whole fish _____________lbs.

Length of fish (fork length) _____________inches

Fish #2: Weight of whole fish _____________lbs.

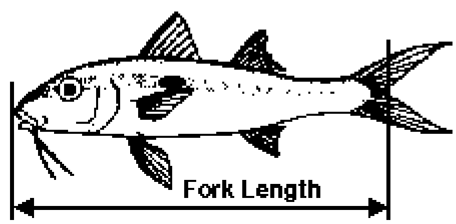
Length of fish (fork length) _____________inches

Fish #3: Weight of whole fish _____________lbs.

Length of fish (fork length) _____________inches

Ship fish samples* to:

Dennis Cladis
Purdue University
Dept. of Nutrition Science, Stone Hall
700 West State Street
West Lafayette, IN 47907-2059
Phone: 765-496-1389



*e -mail photo to dcladis@purdue.edu (include sample number from top)

Figure A.1 – Sample cards distributed to fish vendors.

Table A.1 – Tracking information, mercury measurements, and full fatty acid profiles for all species examined in this study. Vendors are coded by region (i.e., GL, MA, NE, NW, SE, or SW) and numbered to represent different vendors used in each region. "Date" represents the date the fish were harvested or received in lab, based on availability of tracking data. "Farm/Wild" indicates whether samples were from a farmed or wild-caught source. "Location" represents where samples were captured, including country and body of water where available. Fish length (in inches) and weight (in pounds) are given in the "fish 1", "fish 2", and "fish 3" rows. Some samples were filleted before arrival, so fish measurements were unavailable or estimated (indicated by "*"). Moisture was measured in triplicate on all composited samples, and the results are given as percentages. Total fat was measured in duplicate for all samples via the Folch method, and the results are given as percentages. Several samples (19.33%) had residual solvent or salt after extraction via the Folch method. Total fat for these samples was calculated by integrating the full GC spectrum and multiplying the result by 1.20 (a correction factor obtained by comparing GC spectra to total fat measurements obtained directly from the Folch method). Mercury was measured in triplicate for all composited samples, and results are given in parts per billion (ppb). Fatty acids were measured in duplicate for all composited samples, with all results given in mg/100 g. Samples with individual fatty acids below the limit of quantitation (< 1 mg/100 g) are left blank (indicated by "–"). "Σ SFA" is the sum of 12:0, 14:0, 16:0, 18:0, 20:0, 22:0, and 24:0. "Σ MUFA" is sum of 14:1n5, 16:1n7, 18:1n7, 18:1n9, 20:1n9, 22:1n9, and 24:1n9. "Σ (n-3) FA" is sum of 18:3n3, 18:4n3, 20:3n3, 20:4n3, 20:5n3, 22:5n3, and 22:6n3. "Σ (n-6) FA" is sum of 18:2n6, 18:3n6, 20:2n6, 20:3n6, 20:4n6, 22:2n6, and 22:4n6. "Σ PUFA" is sum of total n-3, total n-6, 16:2n4, 16:3n6, and 18:3n4. "mg EPA + DHA in 8 oz" represents the amount of EPA + DHA (in mg) obtained from 8 oz (uncooked weight) of each species. "oz to 1750 mg EPA + DHA" represents the total amount of each species (in ounces, uncooked weight) one would need to consume in order to reach the recommended weekly average of 1750 mg EPA + DHA. For walleye, two composites of three fish were obtained following standard collection protocols. In addition, 18 samples were obtained in July 2013 and total mercury content was measured for each of the 18 samples individually. The 18 values for total mercury are denoted by "^".

Common name *Latin name*	Amberjack, Greater *Seriola dumerili*		Amberjack, Yellowtail *Seriola lalandi*		Bass, Striped *Morone Saxatilis*
Vendor Date Farm/Wild	SE1 Sept 2012 Wild	SE2 June 2013 Wild	SW1 Aug 2012 Wild	SW1 Apr 2013 Wild	NW1 Sept 2012 Farm
Location	Gulf of Mexico, USA	Gulf of Mexico, USA	Pacific Ocean, Mexico	Pacific Ocean, Mexico	USA
Fish 1	*90 lbs	38.5 in, 24.75 lbs	32 in, 13.95 lbs	n/a	*8-10 in, *1.5-2 lbs
Fish 2	*90 lbs	37.5 in, 23.5 lbs	n/a	n/a	*8-10 in, *1.5-2 lbs
Fish 3	*90 lbs	37.5 in, 22 lbs	n/a	n/a	*8-10 in, *1.5-2 lbs
Moisture (%)	78.41 ± 0.09	80.90 ± 0.20	73.96 ± 0.28	73.80 ± 0.40	70.47 ± 2.67
Total Fat (%)	1.15 ± 0.02	0.67 ± 0.02	2.43 ± 0.03	2.39 ± 0.23	8.25 ± 0.32
Mercury (ppb)	922.4 ± 46.98	1013.80 ± 17.51	207.33 ± 11.7	268.48 ± 1.72	25.31 ± 2.00
FA (mg/100 g)					
12:0	-	-	-	-	2.9 ± 0.1
14:0	2.7 ± 0.3	1.8 ± 0.2	87.9 ± 6.1	73.5 ± 1.7	272.3 ± 6.6
16:0	99.9 ± 10.3	85 ± 4.8	465 ± 21.6	390.4 ± 0.1	1518.2 ± 12.6
18:0	45.5 ± 4.5	41.1 ± 2.3	143.4 ± 4.9	160.6 ± 4.9	239.2 ± 11.3
20:0	-	-	4.2 ± 0.2	5 ± 0.1	7.7 ± 0.1
22:0	-	-	2.2 ± 0.5	2.6 ± 0	3.3 ± 0.1
24:0	1.4 ± 0.3	1 ± 0.1	2.6 ± 0.1	4.5 ± 0.2	3.6 ± 0.1
Σ SFA	149.5	129.0	705.3	636.5	2047.2
14:1n5	-	-	-	-	17 ± 0.4
16:1n7	6.6 ± 0.7	4.5 ± 0.4	125.1 ± 7.8	104.3 ± 0.5	564.2 ± 9.3
18:1n7	10 ± 1	8.8 ± 0.6	77.5 ± 3.6	70.4 ± 2	212.3 ± 7.8
18:1n9	39.1 ± 4.5	26.1 ± 2.5	340.1 ± 18.8	329.6 ± 13.2	2238.7 ± 84.1
20:1n9	1.8 ± 0.2	1.2 ± 0.2	42.7 ± 2.1	26.1 ± 1.8	135.2 ± 0.6
22:1n9	-	-	5.8 ± 0.3	4 ± 0.4	8.9 ± 0.2
24:1n9	2.6 ± 0.3	2.4 ± 0.2	12.8 ± 1	14 ± 1.1	8.2 ± 0.9
Σ MUFA	60.1	43.1	604.0	548.4	3184.5
16:2n4	1.8 ± 0.2	-	8 ± 0.4	6.1 ± 0	30.7 ± 0.7
16:3n4	1.2 ± 0	-	4.9 ± 0.3	5 ± 0.1	27.8 ± 0.7
LA	3.9 ± 0.5	3.9 ± 0.2	30 ± 1.7	23.3 ± 0.5	732.8 ± 6.7
ALA	-	-	18.2 ± 0.7	9.7 ± 0.3	87.6 ± 1
18:3n4	-	-	5.2 ± 0	4 ± 0	17.4 ± 0
18:3n6	-	-	3.2 ± 0.2	2.5 ± 0	17.9 ± 0.3
SDA	-	-	30.8 ± 1.6	12.3 ± 0.2	45.9 ± 2.2
20:2n6	-	-	5.3 ± 0.2	3.5 ± 0.2	52.7 ± 0.1
20:3n3	-	-	3.7 ± 0.1	1.6 ± 0.1	5 ± 0
20:3n6	-	1.3 ± 0.1	2.9 ± 0.3	3.7 ± 0.1	11.9 ± 0.2
20:4n3	-	-	15.5 ± 1	10 ± 0.3	33.7 ± 0.3
ARA	24.4 ± 3	37.4 ± 1.9	29 ± 1.3	36.7 ± 0.6	62.2 ± 0.5
EPA	10.7 ± 1.4	10.4 ± 0.6	182.3 ± 11.9	132.2 ± 4.6	357.9 ± 1.1
22:2n6	-	-	-	-	3.6 ± 0.2
22:4n6	6.5 ± 0.8	9.4 ± 0.5	4.4 ± 0.4	5.6 ± 0	12.4 ± 0.1
DPAn-3	13.5 ± 1.5	12.7 ± 0.4	56.1 ± 3.6	72.1 ± 3.3	108.1 ± 0.2
DHA	134.4 ± 14.4	115 ± 6.6	463.8 ± 24.2	419.4 ± 23	373 ± 0.2
Σ (n-3) FA	158.7	138.1	770.4	657.3	1011.2
Σ (n-6) FA	34.8	52.0	74.9	75.3	893.5
Σ PUFA	196.5	190.1	863.5	747.7	1980.5
mg EPA + DHA in 8 oz	329.2	284.5	1465.2	1251.2	1657.8
oz to 1750 mg EPA + DHA	42.79	49.30	9.57	11.21	8.45

Common name *Latin name*	Bass, Striped *Morone Saxatilis*					
Vendor Date Farm/Wild	NW1 Mar 2013 Farm	SE1 Apr 2013 Farm	SW1 Aug 2012 Farm	SW1 Apr 2013 Farm	MA1 Apr 2013 Wild	GL1 Nov 2010 Wild
Location	USA	USA	USA	USA	USA	Atlantic Ocean
Fish 1	15 in, 1.8 lbs	n/a	n/a	14 in, 2 lbs	23 in, 5.62 lbs	20 in, 6 lbs
Fish 2	14 in, 1.7 lbs	n/a	n/a	14.2 in, 2.5 lbs	23 in, 5.21 lbs	19 in, 5.9 lbs
Fish 3	15 in, 1.8 lbs	n/a	n/a	14.3 in, 2.5 lbs	22.5 in, 4.58 lbs	22 in, 6.3 lbs
Moisture (%)	76.23 ± 0.24	75.32 ± 0.1	74.64 ± 0.11	72.35 ± 0.81	75.22 ± 0.55	78.23 ± 0.25
Total Fat (%)	3.86 ± 0.07	5.60 ± 0.07	5.48 ± 0.18	7.68 ± 0.69	3.51 ± 0.33	1.84 ± 0.06
Mercury (ppb)	17.36 ± 2.14	34.02 ± 0.77	33.89 ± 2.64	15.75 ± 1.05	71.47 ± 2.30	66.77 ± 3.56
<u>FA (mg/100 g)</u>						
12:0	1.2 ± 0.2	1.6 ± 0	1.9 ± 0.1	1.9 ± 0	2.7 ± 0	-
14:0	83.7 ± 8.7	134.9 ± 1.7	167.1 ± 5.2	149.3 ± 2.9	156.5 ± 7.8	43.2 ± 7
16:0	773.1 ± 68.9	894.3 ± 25.9	1029.9 ± 30.9	1275.8 ± 9.7	598.6 ± 25.7	217.8 ± 18.2
18:0	126.1 ± 9.4	153.4 ± 0.8	161.4 ± 3.9	209.6 ± 9.6	112.1 ± 0.3	56.2 ± 4.3
20:0	3.9 ± 0.4	3.9 ± 0.3	4.2 ± 0.2	7.3 ± 0.5	4.4 ± 0.1	2 ± 0.3
22:0	2 ± 0.3	1.7 ± 0.2	2.2 ± 0.2	2.7 ± 0.1	2 ± 0	-
24:0	2 ± 0.2	2.8 ± 0.1	2.6 ± 0.4	3.4 ± 0.1	2 ± 0	1.1 ± 0
Σ SFA	992.1	1192.6	1369.3	1650.0	878.2	320.3
14:1n5	6.5 ± 0.7	10.3 ± 0.5	11.2 ± 0.7	9.4 ± 0.2	4.3 ± 0.3	2.5 ± 0.3
16:1n7	233.2 ± 23.9	372.1 ± 11.1	388.8 ± 13	394.4 ± 5.6	357.3 ± 10.9	75.5 ± 10.8
18:1n7	95.5 ± 8.1	151.6 ± 1.7	139.9 ± 4	168.3 ± 4.3	135.3 ± 1.9	35.4 ± 4.8
18:1n9	1133.9 ± 108.6	1802.8 ± 26.2	1757.4 ± 60.6	2284.1 ± 53.7	399.9 ± 1.7	100 ± 13.3
20:1n9	65.9 ± 6.5	112 ± 6.6	106.7 ± 4.6	142.6 ± 3.5	58.9 ± 0.5	15 ± 3.7
22:1n9	4.4 ± 0.8	5.3 ± 0.3	5.6 ± 0.5	7.8 ± 0.4	6.7 ± 1	1.7 ± 0.3
24:1n9	4.7 ± 0.3	6.9 ± 0.2	5.2 ± 0.3	7.2 ± 0.7	9.1 ± 0.1	3.8 ± 0.2
Σ MUFA	1544.2	2461.0	2414.8	3013.8	971.6	233.9
16:2n4	7.1 ± 0.7	15.7 ± 0.3	18.2 ± 0.6	12.5 ± 0.4	43 ± 1.2	8.1 ± 1
16:3n4	5.6 ± 0.7	11.8 ± 0.1	14.8 ± 0.7	11.2 ± 0.1	47.2 ± 0.5	9.3 ± 1.2
LA	620 ± 53.5	786.4 ± 29.7	668.5 ± 19.8	1065.2 ± 17.1	37.5 ± 0	12.2 ± 1.7
ALA	50.8 ± 4.7	81.4 ± 3.5	77.9 ± 0.8	96.2 ± 2.1	41.9 ± 0.6	10.3 ± 1.2
18:3n4	4.5 ± 0.5	6.9 ± 0.1	10.3 ± 0.4	5.3 ± 0.2	16.6 ± 0	5.1 ± 0.7
18:3n6	11.4 ± 0.7	12.9 ± 0.4	13.9 ± 0.5	22.3 ± 0.3	6.9 ± 0.1	1.6 ± 0.3
SDA	12.3 ± 1.3	17.6 ± 0.7	20.6 ± 0.7	24.4 ± 0.1	62.7 ± 0.1	16.2 ± 2.3
20:2n6	38 ± 3.6	50.3 ± 2.7	46.3 ± 1.8	59.8 ± 0.4	10 ± 0.2	4.1 ± 0.6
20:3n3	2.2 ± 0.4	2.9 ± 0.2	2.7 ± 0.4	3 ± 0.2	6.9 ± 0.5	2.1 ± 0.3
20:3n6	7.2 ± 0.7	10.9 ± 0.5	10 ± 0.3	10.5 ± 0.2	5.8 ± 0	2.2 ± 0.3
20:4n3	9.1 ± 1	15.9 ± 0.8	18.1 ± 0.8	13.7 ± 0.5	32.3 ± 1	10.3 ± 1.5
ARA	43 ± 3.1	56.6 ± 2.3	53.4 ± 1.8	51.4 ± 0.3	48.5 ± 2.9	33.7 ± 1.9
EPA	153.7 ± 12.1	224 ± 10.9	222.1 ± 7.4	212.1 ± 0.2	305.7 ± 14.4	97.1 ± 12.2
22:2n6	1.6 ± 0.5	2.1 ± 0.4	1.9 ± 0	3.3 ± 0	-	-
22:4n6	5.8 ± 0.5	7.8 ± 0.6	7.8 ± 0.7	7.2 ± 0.2	-	6.6 ± 0.8
DPAn-3	50.2 ± 3.8	78.5 ± 4.6	68.9 ± 2.9	64.6 ± 0.6	75.3 ± 6.5	31.7 ± 4.1
DHA	199 ± 12.1	275 ± 15.3	230.7 ± 11.1	255.9 ± 2.6	346.3 ± 27.4	233.7 ± 17
Σ (n-3) FA	477.2	695.4	641.0	669.9	871.1	401.4
Σ (n-6) FA	727.1	926.9	801.6	1219.6	108.7	60.4
Σ PUFA	1221.5	1656.6	1486.0	1918.6	1086.5	484.2
mg EPA + DHA in 8 oz	800.0	1131.8	1027.1	1061.3	1478.8	750.4
oz to 1750 mg EPA + DHA	17.54	12.39	13.65	13.19	9.49	18.73

Common name *Latin name*	Bass, Striped *Morone Saxatilis*			Bluefish *Pomatomus saltatrix*	
Vendor Date Farm/Wild	NE1 Dec 2012 Wild	MA2 July 2013 Wild	MA3 June 2013 Wild	MA1 Apr 2013 Wild	MA2 July 2013 Wild
Location	USA	Chesapeak Bay, USA	North Atlantic Ocean, USA	Atlantic Ocean, USA	Atlantic Ocean, USA
Fish 1	35 in, 31 lbs	19 in, 2.4 lbs	22.5 in, 4.95 lbs	15.25 in, 1.52 lbs	10 in, 1 lb
Fish 2	25 in, 32 lbs	19 in, 2.2 lbs	22.75 in, 4.55 lbs	13.5 in, 1.24 lbs	11 in, 1 lb
Fish 3	29 in, 18 lbs	20 in, 2.6 lbs	24.75 in, 7.35 lbs	13.25 in, 1.03 lbs	11 in, 1 lb
Moisture (%)	76.56 ± 0.98	78.64 ± 0.02	76.07 ± 0.83	70.10 ± 0.58	76.27 ± 0.05
Total Fat (%)	2.50 ± 0.06	1.15 ± 0.06	3.12 ± 0.22	8.76 ± 0.25	2.37 ± 0.17
Mercury (ppb)	296.19 ± 5.24	63.48 ± 3.72	89.64 ± 8.06	233.08 ± 7.08	239.52 ± 3.55
FA (mg/100 g)					
12:0	1.5 ± 0.2	-	1.7 ± 0	5 ± 0.2	1.2 ± 0
14:0	117.3 ± 12.2	23.1 ± 1.2	145 ± 6.7	283 ± 6.7	92.7 ± 2.1
16:0	364.2 ± 36.4	223.7 ± 12.5	507.3 ± 37.5	1526.8 ± 51.6	531.1 ± 10.7
18:0	76.1 ± 7.2	57.9 ± 3.3	100 ± 3.4	481.5 ± 31.6	172.3 ± 5.2
20:0	2.9 ± 0.4	1.4 ± 0.1	4.4 ± 0.1	27.8 ± 1.9	7.6 ± 0.2
22:0	1.4 ± 0.2	-	2.4 ± 0.2	17.4 ± 0.3	4.4 ± 0.1
24:0	1.3 ± 0.1	-	2.4 ± 0.2	8.5 ± 0.7	3.2 ± 0
Σ SFA	564.6	306.0	763.1	2350.0	812.5
14:1n5	1.9 ± 0.1	1.3 ± 0.1	4.5 ± 0.2	3.3 ± 0.1	-
16:1n7	148.8 ± 20.1	75.8 ± 3.5	311.8 ± 24.1	509.6 ± 10.2	214.9 ± 4.4
18:1n7	63.4 ± 7.1	46.2 ± 3.2	112.1 ± 6.6	232.9 ± 5.8	90.3 ± 2.6
18:1n9	215.9 ± 17.6	185.4 ± 11	296.3 ± 8.9	1116.6 ± 102.8	332.3 ± 6.4
20:1n9	105.8 ± 0.5	19.6 ± 1.4	41.5 ± 1.8	113.5 ± 11.2	25.6 ± 0.7
22:1n9	9.9 ± 0.2	1.6 ± 0.1	5.8 ± 0.6	35.6 ± 2.4	6.5 ± 0.2
24:1n9	12.7 ± 0.3	3.6 ± 0	10.4 ± 1	37.6 ± 2.6	11.2 ± 0.1
Σ MUFA	558.3	333.5	782.5	2049.1	680.9
16:2n4	14.1 ± 2.2	4 ± 0.1	37.6 ± 3.8	26.7 ± 5.2	8.6 ± 0.1
16:3n4	12.9 ± 2	2 ± 0.1	32.7 ± 3.2	20.3 ± 4.1	7.5 ± 0.1
LA	26.8 ± 2	6.3 ± 0.2	46.1 ± 3.6	81.1 ± 5.2	29.3 ± 0.6
ALA	18.1 ± 1.5	5.6 ± 0.1	54.3 ± 8	79.5 ± 12.6	15.4 ± 0.5
18:3n4	7.6 ± 1	1.8 ± 0.1	14.8 ± 1.7	21.1 ± 0.1	6.3 ± 0.3
18:3n6	2.7 ± 0.6	-	7.3 ± 0.7	9.3 ± 0.7	4 ± 0
SDA	35.9 ± 2.9	3.5 ± 0.1	59.4 ± 8.6	69.3 ± 10.9	16.8 ± 0.4
20:2n6	6.4 ± 0.3	4.5 ± 0.3	11 ± 0.5	23.1 ± 1	10.2 ± 0.3
20:3n3	3.8 ± 0.2	1.4 ± 0.1	7.3 ± 0.7	16.4 ± 1.4	4.4 ± 0.1
20:3n6	2.6 ± 0.3	1.6 ± 0.1	6.3 ± 0.5	11.5 ± 0.5	5.3 ± 0.2
20:4n3	20.3 ± 2.2	3.7 ± 0.2	38 ± 5.8	49.6 ± 6.3	12.9 ± 0.4
ARA	31.1 ± 2.9	24.3 ± 1.1	48.9 ± 5.2	116.4 ± 10.2	53.3 ± 2.3
EPA	189.5 ± 18.2	82.7 ± 3.5	216.7 ± 35.7	291.1 ± 8.1	113.6 ± 2.5
22:2n6	-	-	-	2.4 ± 0.2	-
22:4n6	6 ± 0.4	10.6 ± 0.6	10.6 ± 0.9	54.5 ± 10.1	21.1 ± 0.8
DPAn-3	47.2 ± 4.5	34 ± 1.1	71.7 ± 8.4	174.7 ± 10.3	70 ± 2.1
DHA	354.1 ± 24.2	164.9 ± 6.1	366.9 ± 59.4	923.3 ± 3.8	277.7 ± 12
Σ (n-3) FA	669.0	295.8	814.3	1603.7	510.7
Σ (n-6) FA	75.7	47.3	130.2	298.5	123.1
Σ PUFA	779.3	350.9	1029.6	1970.4	656.1
mg EPA + DHA in 8 oz	1232.8	561.7	1323.6	2754.0	887.4
oz to 1750 mg EPA + DHA	11.39	24.95	10.72	5.09	15.79

Common name	Bluefish	Catfish, Channel			
Latin name	*Pomatomus saltatrix*	*Ictalurus punctatus*			
Vendor Date Farm/Wild	MA3 June 2013 Wild	GL1 Oct 2010 Farm	GL1 Aug 2012 Farm	NW1 Sept 2012 Farm	NE1 Dec 2012 Farm
Location	North Atlantic Ocean, USA	Alabama, USA	USA	Alabama, USA	USA
Fish 1	22 in, 5 lbs	n/a	11.5 in, 1.24 lbs	*12-16 in, 1-3 lbs	n/a
Fish 2	20.75 in, 4.2 lbs	n/a	11.5 in, 1.3 lbs	*12-16 in, 1-3 lbs	n/a
Fish 3	21 in, 4.25 lbs	n/a	12 in, 1.36 lbs	*12-16 in, 1-3 lbs	n/a
Moisture (%)	76.09 ± 0.45	74.74 ± 0.61	73.78 ± 0.12	76.7 ± 1.32	78.62 ± 0.87
Total Fat (%)	2.44 ± 0.30	8.30 ± 0.55	8.38 ± 0.15	6.10 ± 0.11	6.60 ± 0.45
Mercury (ppb)	279.09 ± 21.84	1.32 ± 0.05	0.08 ± 0.13	0.72 ± 0.45	0.14 ± 0.15
FA (mg/100 g)					
12:0	-	1.3 ± 0	1.8 ± 0	-	1.2 ± 0
14:0	89.2 ± 9.5	69.8 ± 6.9	103.2 ± 0.4	58.7 ± 0.3	57.5 ± 4
16:0	367.1 ± 25.9	1460.7 ± 140.8	1742.6 ± 2.7	1004.3 ± 12.9	938 ± 91.3
18:0	102 ± 8	242.2 ± 4.5	455 ± 28.8	252.4 ± 3.8	248.8 ± 31.1
20:0	4.3 ± 0.5	16.4 ± 1.4	12.4 ± 0.2	7.1 ± 0.2	7 ± 0.9
22:0	-	11.9 ± 1	4.1 ± 0.5	3.2 ± 0.2	2.7 ± 0.5
24:0	1.6 ± 0.1	5.1 ± 0.7	2.9 ± 0.3	2 ± 0.2	1.6 ± 0.6
Σ SFA	564.3	1807.3	2322.1	1327.7	1256.8
14:1n5	-	1.1 ± 0.1	1.3 ± 0.2	-	-
16:1n7	63.1 ± 6.9	174.8 ± 15.7	262.5 ± 0.4	127.9 ± 2.1	145.8 ± 11.9
18:1n7	44.8 ± 4.6	83.3 ± 7.8	217.3 ± 16.1	103.6 ± 2	112.7 ± 0.4
18:1n9	238.1 ± 28.2	4326.4 ± 387	4245.5 ± 264.1	2064.4 ± 21.6	2562.8 ± 334.1
20:1n9	144.1 ± 18.2	144 ± 10.7	113.4 ± 1.1	60.4 ± 2.1	66 ± 9.5
22:1n9	18.1 ± 1.6	8 ± 0.5	7.2 ± 0.6	4.1 ± 0.6	3.7 ± 0.3
24:1n9	22.9 ± 2.3	1.9 ± 0	2.5 ± 0.1	1.9 ± 0.3	1.6 ± 0.1
Σ MUFA	531.1	4739.5	4849.6	2362.2	2892.5
16:2n4	4.3 ± 0.6	-	1.2 ± 0.1	-	-
16:3n4	2.2 ± 0.3	-	10.4 ± 0.3	-	-
LA	22.4 ± 2.3	1278 ± 127.7	1229.2 ± 1.6	770.6 ± 7.9	728.5 ± 54.6
ALA	18.5 ± 1.9	75.6 ± 8.1	81.7 ± 1.1	49.7 ± 0.2	52.3 ± 2.9
18:3n4	3.1 ± 0.3	1.7 ± 0.1	2.8 ± 0.5	2.3 ± 0.3	1.8 ± 0.4
18:3n6	1.6 ± 0.1	28.5 ± 2.8	29 ± 1.2	19.4 ± 0.3	25.6 ± 1.6
SDA	42.8 ± 4.2	8.8 ± 0.8	5.8 ± 2.4	3.3 ± 0.5	4.5 ± 0
20:2n6	5.1 ± 0.5	78.9 ± 8.7	64.2 ± 0.3	38.7 ± 1.5	34.6 ± 3.6
20:3n3	3.3 ± 0.2	5.6 ± 0.6	5.9 ± 0.1	3.4 ± 0.1	3.6 ± 0.2
20:3n6	1.1 ± 0.1	82.6 ± 7.8	75.5 ± 0.2	50.2 ± 2.4	56.7 ± 3.4
20:4n3	13.1 ± 1.2	4.8 ± 0.8	6.1 ± 0.1	3.3 ± 0.1	4.6 ± 0.2
ARA	20.4 ± 0.2	45.9 ± 4.2	51.1 ± 0	39.9 ± 3.1	43.4 ± 1.2
EPA	92.5 ± 3.5	6.4 ± 0.2	9.5 ± 0	5.6 ± 0.8	9.1 ± 0.6
22:2n6	-	7.9 ± 1.1	7.3 ± 0.1	5.2 ± 0.1	4.5 ± 0.6
22:4n6	4.5 ± 0.5	6.6 ± 0.8	7.5 ± 0.2	4.9 ± 0.5	5.5 ± 0
DPAn-3	35.9 ± 2.5	8.4 ± 0.9	12.3 ± 0	7.4 ± 0.6	10.9 ± 0.8
DHA	367.4 ± 5.8	21.8 ± 2.3	40.4 ± 0.3	28.8 ± 3.3	36.1 ± 1.6
Σ (n-3) FA	573.4	131.5	161.7	101.5	121.0
Σ (n-6) FA	55.2	1528.4	1463.8	928.9	898.8
Σ PUFA	638.3	1661.6	1639.8	1032.7	1021.7
mg EPA + DHA in 8 oz	1043.0	64.1	113.1	78.1	102.6
oz to 1750 mg EPA + DHA	13.43	219.36	123.75	180.56	136.70

Common name	Catfish, Channel				
Latin name	*Ictalurus punctatus*				
Vendor Date Farm/Wild	NE3 Oct 2012 Farm	NE5 July 2013 Farm	NW1 Mar 2013 Farm	SE2 Nov 2012 Farm	SE1 Apr 2013 Farm
Location	Mississippi, USA	Alabama, USA	USA	USA	USA
Fish 1	n/a	n/a	*14-16 in, 2-3 lbs	n/a	n/a
Fish 2	n/a	n/a	*14-16 in, 2-3 lbs	n/a	n/a
Fish 3	n/a	n/a	*14-16 in, 2-3 lbs	n/a	n/a
Moisture (%)	78.86 ± 0.78	75.61 ± 0.49	77.98 ± 0.33	81.72 ± 1.55	77.79 ± 0.18
Total Fat (%)	6.44 ± 0.16	7.42 ± 0.01	8.38 ± 0.18	11.72 ± 0.93	6.07 ± 0.06
Mercury (ppb)	0.00 ± 0.00	1.36 ± 0.34	0.24 ± 0.06	0.41 ± 0.16	1.31 ± 0.38
FA (mg/100 g)					
12:0	1 ± 0.1	1.4 ± 0.1	1.6 ± 0	-	1.1 ± 0
14:0	56.1 ± 3.2	83.1 ± 6.4	84.3 ± 0.2	45.7 ± 0.8	66.1 ± 1
16:0	989.8 ± 32.5	1503.5 ± 98.1	1366.2 ± 7.8	940.4 ± 17.8	1237.9 ± 2.4
18:0	239.5 ± 2.1	412.4 ± 21.5	330.8 ± 6.2	240.3 ± 11.4	364.4 ± 19
20:0	7.4 ± 0	10.5 ± 0.6	9.2 ± 0.2	9.4 ± 0.3	9.2 ± 0
22:0	2.9 ± 0	3.7 ± 0.1	3.5 ± 0.2	5 ± 0	4.5 ± 0.1
24:0	1.9 ± 0.1	2.1 ± 0	1.8 ± 0.2	2.3 ± 0.1	1.9 ± 0.2
Σ SFA	1298.7	2016.8	1797.4	1243.1	1685.0
14:1n5	-	1.1 ± 0.1	1.6 ± 0.6	-	-
16:1n7	123.1 ± 8.3	217.4 ± 17.4	249.6 ± 1.7	130.5 ± 1.7	161.5 ± 1.1
18:1n7	109.8 ± 1.4	142.3 ± 10.9	160.8 ± 14.7	102.2 ± 8.6	146.4 ± 9.5
18:1n9	2401.4 ± 80.9	3520.9 ± 216.1	3073.7 ± 11.4	2589.1 ± 111.9	2940.7 ± 174.3
20:1n9	71.3 ± 2.3	101.1 ± 7.4	97.7 ± 2.7	92.2 ± 3.2	96.7 ± 1.9
22:1n9	4.3 ± 0	5.6 ± 0.5	5.2 ± 0.2	4.8 ± 0.1	5.5 ± 0.3
24:1n9	1.8 ± 0.1	1.9 ± 0.2	1.7 ± 0.1	1.4 ± 0.1	1.9 ± 0.1
Σ MUFA	2711.8	3990.2	3590.4	2920.1	3352.7
16:2n4	1.1 ± 0.1	-	-	-	-
16:3n4	1.1 ± 0.1	-	-	-	-
LA	721.1 ± 10.6	1051.4 ± 56.6	844.9 ± 4	774.8 ± 18.6	1011.3 ± 6.8
ALA	50.5 ± 0.4	62.5 ± 3.5	58 ± 0.6	44.2 ± 1.2	57 ± 1.1
18:3n4	2.4 ± 0.3	-	1.9 ± 1.3	-	2.6 ± 0.3
18:3n6	17.1 ± 1.1	35.3 ± 2.6	23.4 ± 0.1	20.1 ± 0.9	33.3 ± 0.2
SDA	3.2 ± 0	5.6 ± 0.2	4.5 ± 2.4	3.3 ± 1.2	3.7 ± 0.2
20:2n6	42.8 ± 2.1	60 ± 3.6	42.3 ± 7.3	48 ± 0.2	50.5 ± 0.6
20:3n3	4.1 ± 0.1	4.5 ± 0.6	4.4 ± 0	3.5 ± 0.1	3.7 ± 0.1
20:3n6	53 ± 3.8	88.2 ± 5.6	72.4 ± 1.3	63.4 ± 0.7	79.1 ± 0.1
20:4n3	4.7 ± 0.1	5.4 ± 0.7	5.3 ± 0.1	3.5 ± 0.1	4.2 ± 0
ARA	43.4 ± 2.6	74.6 ± 5.6	64.3 ± 2.7	41.7 ± 0.2	65.1 ± 1.1
EPA	8.4 ± 0.2	11.2 ± 0.6	8.3 ± 0.4	5.4 ± 0.1	6.1 ± 0
22:2n6	4.6 ± 0.1	7.6 ± 0.7	6.1 ± 0.1	4.9 ± 0	7.1 ± 0.2
22:4n6	6 ± 0.3	9.2 ± 1	11.3 ± 0.9	7.7 ± 1.3	8.4 ± 0.3
DPAn-3	10 ± 0.5	15.2 ± 1.1	12.6 ± 0.4	7.5 ± 0.1	11.3 ± 0.1
DHA	38.7 ± 1.9	44.8 ± 3.2	31.8 ± 1.4	17.8 ± 0	40.6 ± 0.1
Σ (n-3) FA	119.5	149.2	124.8	85.3	126.6
Σ (n-6) FA	887.9	1326.4	1064.7	960.5	1254.8
Σ PUFA	1012.1	1475.5	1191.5	1045.8	1383.9
mg EPA + DHA in 8 oz	106.7	127.1	90.9	52.8	106.0
oz to 1750 mg EPA + DHA	131.28	110.42	154.13	265.40	132.07

Common name *Latin name*	Catfish, Channel *Ictalurus punctatus*		Cod, Atlantic *Gadus morhua*		
Vendor Date Farm/Wild	SW1 Aug 2012 Farm	SW1 Apr 2013 Farm	SW1 Apr 2013 Farm	GL1 Jan 2011 Wild	NE2 Nov 2012 Wild
Location	USA	USA	Atlantic Ocean, USA	Atlantic Ocean	Gulf of Maine, USA
Fish 1	n/a	n/a	n/a	20.5 in, 9.8 lbs	24 in, 8.2 lbs
Fish 2	n/a	n/a	n/a	21 in, 10.2 lbs	23 in, 6 lbs
Fish 3	n/a	n/a	n/a	20 in, 10 lbs	24 in, 6.5 lbs
Moisture (%)	74 ± 0.43	75.49 ± 1.43	83.14 ± 0.05	81.58 ± 0.07	82.99 ± 0.09
Total Fat (%)	9.13 ± 0.45	9.07 ± 0.59	1.04 ± 0.07	0.51 ± 0.02	0.72 ± 0.09
Mercury (ppb)	0.53 ± 0.33	0.94 ± 0.37	125.54 ± 10.62	117.45 ± 2.50	150.24 ± 4.36
FA (mg/100 g)					
12:0	1.5 ± 0	1.3 ± 0.1	-	-	-
14:0	87.1 ± 1.5	79.1 ± 7.4	4.1 ± 0.1	4.5 ± 0.1	5.6 ± 0.4
16:0	1690.3 ± 31.4	1390.6 ± 145.4	98.3 ± 6.8	80 ± 0.1	82.2 ± 6.9
18:0	485.4 ± 2.6	358.4 ± 39.7	24.9 ± 1.6	17.8 ± 0.4	18 ± 1.9
20:0	14.8 ± 0.2	10.2 ± 1.3	-	-	-
22:0	5.1 ± 0.1	3.6 ± 0.8	-	-	-
24:0	3 ± 0.1	2.2 ± 0.2	-	-	-
Σ SFA	2287.2	1845.5	127.4	102.3	105.7
14:1n5	1.7 ± 0.6	-	-	-	-
16:1n7	212.4 ± 5.7	177.4 ± 17.8	7.2 ± 0.1	5.1 ± 0.2	4.9 ± 0.8
18:1n7	157.8 ± 4.5	150.8 ± 13.1	26.5 ± 0.7	9.7 ± 0.2	9.5 ± 1.5
18:1n9	4254.7 ± 132.3	3515.7 ± 361.2	44.3 ± 3.3	32.8 ± 1.1	28 ± 4.5
20:1n9	130.7 ± 1	115.9 ± 6.9	3.3 ± 0.1	8.2 ± 0.2	10.5 ± 1.4
22:1n9	7 ± 0.1	5.9 ± 0.3	-	-	-
24:1n9	2.9 ± 0.1	2 ± 0.1	2.9 ± 0.7	1.7 ± 0.3	1.7 ± 0.5
Σ MUFA	4767.1	3967.8	84.2	57.5	54.6
16:2n4	-	1.2 ± 0.2	-	-	-
16:3n4	-	-	-	-	-
LA	1319.9 ± 13.2	1079.3 ± 147.8	3.1 ± 0.5	3.5 ± 0.1	4 ± 0.5
ALA	69.8 ± 0.1	65.2 ± 9.7	1.1 ± 0.2	1.1 ± 0	1.1 ± 0.2
18:3n4	3.8 ± 0.1	3.3 ± 0.8	-	-	-
18:3n6	30.5 ± 0.6	30.2 ± 2.3	-	-	-
SDA	6.7 ± 0.1	5.4 ± 0.5	1.7 ± 0.1	1.5 ± 0.1	1.6 ± 0.2
20:2n6	74.5 ± 0.8	55.5 ± 7.1	-	-	-
20:3n3	5.2 ± 0	4.6 ± 0.7	-	-	-
20:3n6	82.8 ± 0.3	78.2 ± 3.3	-	-	-
20:4n3	5.6 ± 0.2	5.6 ± 0.5	1.9 ± 0.1	1.6 ± 0	1.7 ± 0.3
ARA	55 ± 1.1	60.8 ± 2.5	18.5 ± 0.3	9.2 ± 0.3	9 ± 1
EPA	12.9 ± 0.7	10.7 ± 1	85.2 ± 4.8	50.3 ± 1.5	58.5 ± 6.3
22:2n6	8.9 ± 0.1	6.8 ± 0.9	-	-	-
22:4n6	8.9 ± 0.1	8.3 ± 0.3	-	-	-
DPAn-3	15.2 ± 0.1	13.1 ± 0.6	7.8 ± 0.3	5.5 ± 0	6 ± 0.8
DHA	43 ± 0.3	43.6 ± 0.4	167.6 ± 9.6	140.8 ± 4.4	145.4 ± 17.2
Σ (n-3) FA	158.4	148.2	265.2	200.8	214.3
Σ (n-6) FA	1580.6	1319.1	21.6	12.7	13.0
Σ PUFA	1742.8	1471.8	286.9	213.5	227.3
mg EPA + DHA in 8 oz	126.9	123.1	573.3	433.5	462.5
oz to 1750 mg EPA + DHA	110.32	113.75	24.46	32.32	30.48

Common name	Cod, Atlantic					
Latin name	*Gadus morhua*					
Vendor Date Farm/Wild	NE4 Apr 2013 Wild	NE2 May 2013 Wild	NW1 Apr 2013 Wild	SE1 Sept 2012 Wild	SE1 Mar 2013 Wild	NE3 Oct 2012 Wild
Location	Gulf of Maine, USA	Gulf of Maine, USA	Atlantic Ocean, USA	North Atlantic Ocean, USA	North Atlantic Ocean, Iceland	Iceland
Fish 1	23.5 in, 4.9 lbs	n/a	*12 in, *1.7 lbs	n/a	n/a	8 lbs
Fish 2	26 in, 6.35 lbs	n/a	*13 in, *1.9 lbs	n/a	n/a	8 lbs
Fish 3	26 in, 6.4 lbs	n/a	*10 in, *1.6 lbs	n/a	n/a	8 lbs
Moisture (%)	82.92 ± 0.08	84.47 ± 0.08	81.74 ± 0.35	83.12 ± 0.09	81.64 ± 0.06	82.66 ± 0.03
Total Fat (%)	1.07 ± 0.10	0.53 ± 0.03	1.08 ± 0.06	0.59 ± 0.02	0.59 ± 0.02	0.81 ± 0.09
Mercury (ppb)	77.66 ± 2.61	22.14 ± 1.93	38.70 ± 0.38	32.13 ± 0.49	71.12 ± 2.60	103.59 ± 7.72
FA (mg/100 g)						
12:0	-	-	-	-	-	-
14:0	4.1 ± 0.1	3.8 ± 0.6	5.7 ± 0.3	3.4 ± 0.4	5.9 ± 0.1	6.5 ± 0.4
16:0	99.2 ± 6.5	80 ± 9.6	106.9 ± 4.7	92.8 ± 9.8	95.1 ± 3.7	104.7 ± 3.2
18:0	25 ± 1.8	18.9 ± 1.9	26.9 ± 2	25.3 ± 2.8	24.1 ± 0.2	24.8 ± 0.4
20:0	-	-	-	1.5 ± 0.2	-	-
22:0	-	-	-	-	-	-
24:0	-	-	-	-	-	-
Σ SFA	128.2	102.7	139.5	123.1	125.1	136.0
14:1n5	-	-	-	-	-	-
16:1n7	6.2 ± 0.8	3.3 ± 0.5	8.6 ± 0.6	6.4 ± 0.7	8.2 ± 0.1	7.2 ± 0.2
18:1n7	18.2 ± 1.8	9.4 ± 1.1	26.2 ± 1.9	25.3 ± 2.5	17.6 ± 1	16.3 ± 0.7
18:1n9	53.2 ± 4.3	23.7 ± 2.6	47.6 ± 4	25.3 ± 2.7	36.1 ± 2.7	39.2 ± 0.2
20:1n9	9 ± 0.6	7.3 ± 0.7	5.1 ± 0.6	1.8 ± 0.1	9 ± 0.7	12.4 ± 0
22:1n9	2.9 ± 0.2	-	-	-	-	-
24:1n9	3.2 ± 0	2.6 ± 0.1	3.2 ± 0.3	2 ± 0.3	2.2 ± 0.1	2.4 ± 0.2
Σ MUFA	92.7	46.2	90.6	60.9	73.1	77.4
16:2n4	-	-	-	-	-	2 ± 0.1
16:3n4	-	-	-	-	-	-
LA	5.1 ± 0.6	3.8 ± 0.5	3 ± 0.2	1.9 ± 0.2	4.6 ± 0.3	5.6 ± 0.2
ALA	1.3 ± 0.2	1.2 ± 0.1	1.1 ± 0.1	-	1.3 ± 0	1.8 ± 0.1
18:3n4	-	-	-	-	-	-
18:3n6	-	-	-	-	-	-
SDA	1.2 ± 0.1	1.5 ± 0.2	2.3 ± 0.2	1.7 ± 0.2	5.7 ± 0	3.2 ± 0.1
20:2n6	1.9 ± 0.2	-	-	-	-	-
20:3n3	-	-	-	-	-	-
20:3n6	-	-	-	-	-	-
20:4n3	1.8 ± 0.2	1.4 ± 0.1	2 ± 0.2	1.5 ± 0.1	5 ± 0.2	2.8 ± 0
ARA	18.8 ± 1.4	7.2 ± 0.5	11.8 ± 0.8	14.9 ± 1.6	10.9 ± 0.5	12.2 ± 0.1
EPA	61 ± 3.6	46 ± 2.6	110.5 ± 7	103.5 ± 10.7	77.3 ± 2.4	84.4 ± 0.6
22:2n6	-	-	-	-	-	-
22:4n6	1.8 ± 0.2	-	-	1.2 ± 0.2	-	-
DPAn-3	10.3 ± 0.2	4.3 ± 0.7	8 ± 0.3	11.6 ± 1.2	5.7 ± 0.5	8 ± 0.2
DHA	214.5 ± 17.4	165.7 ± 10.1	175.4 ± 11.9	125.6 ± 11.7	179.9 ± 1.2	189.1 ± 2.1
Σ (n-3) FA	290.1	220.1	299.3	244.0	275.0	289.4
Σ (n-6) FA	27.5	11.0	14.9	18.0	15.6	17.8
Σ PUFA	317.6	231.2	314.2	262.0	290.5	309.2
mg EPA + DHA in 8 oz	624.8	480.3	648.5	519.7	583.4	620.4
oz to 1750 mg EPA + DHA	22.48	29.21	21.64	27.07	24.00	22.57

Common name	Cod, Lingcod				Cod, Pacific	
Latin name	*Ophiodon elongates*				*Gadus macrocephalus*	
Vendor	NW1	NW1	SW1	SW1	NW1	NW1
Date	Sept 2012	Mar 2013	Aug 2012	Apr 2013	Sept 2012	Mar 2013
Farm/Wild	Wild	Wild	Wild	Wild	Wild	Wild
Location	Pacific Ocean, Canada	Pacific Ocean, USA	Canada	Pacific Ocean, USA	Pacific Ocean, USA	Pacific Ocean, USA
Fish 1	n/a	*2.7 lbs	32 in, 12 lbs	21 in, 4 lbs	n/a	*25 in, *2.7 lbs
Fish 2	n/a	*2.9 lbs	25 in, 8.15 lbs	24 in, 7 lbs	n/a	*27 in, *2.95 lbs
Fish 3	n/a	*3 lbs	24 in, 5.8 lbs	22 in, 4 lbs	n/a	28 in, 3 lbs
Moisture (%)	81.07 ± 0.14	83 ± 0.15	79.92 ± 0.15	82.09 ± 0.12	82.12 ± 0.05	82.42 ± 0.01
Total Fat (%)	1.09 ± 0.02	1.18 ± 0.05	1.48 ± 0.09	1.44 ± 0.08	0.48 ± 0.03	0.55 ± 0.02
Mercury (ppb)	114.91 ± 8.88	248.86 ± 17.23	211.43 ± 19.97	154.92 ± 9.64	188.39 ± 8.14	154.26 ± 5.96
FA (mg/100 g)						
12:0	-	-	-	-	-	-
14:0	15.2 ± 5.6	14.9 ± 1.7	34.8 ± 2.2	37.8 ± 6.1	3.3 ± 0.3	3.6 ± 0.9
16:0	112.6 ± 16.6	117.2 ± 8.3	195.9 ± 7	191.2 ± 14	66.1 ± 7.1	87.6 ± 15.3
18:0	30.7 ± 2.6	40.2 ± 1.7	38.2 ± 9.7	51.4 ± 1.8	16.7 ± 1.6	20.5 ± 3.3
20:0	-	-	1.2 ± 0.2	1.3 ± 0.1	-	-
22:0	-	-	-	-	-	-
24:0	-	-	-	-	-	-
Σ SFA	158.4	172.3	270.2	281.7	86.1	111.8
14:1n5	-	-	-	-	-	-
16:1n7	14.4 ± 3.9	22.7 ± 3.2	63.3 ± 6.8	61.2 ± 8.8	4.8 ± 0.6	6.2 ± 1.3
18:1n7	14.7 ± 2	27.3 ± 1.8	49.8 ± 5.1	51.6 ± 4.6	11.1 ± 1.3	20.2 ± 3
18:1n9	48 ± 7.1	94 ± 5.5	178.9 ± 23.9	164.9 ± 11.5	26.5 ± 3.9	35.8 ± 5.6
20:1n9	11.4 ± 2.3	13.8 ± 0.7	27.4 ± 2.9	31 ± 3	1.9 ± 0.2	2.1 ± 0.3
22:1n9	1.7 ± 0.4	2.4 ± 0.4	4.5 ± 0.7	7.9 ± 0.4	-	-
24:1n9	4.2 ± 0.6	5.7 ± 0.5	4.9 ± 1.7	9.5 ± 0.2	1.3 ± 0.2	2.1 ± 0.2
Σ MUFA	94.4	165.9	328.8	326.1	45.7	66.4
16:2n4	1.2 ± 0.4	2.1 ± 0.3	4.6 ± 0.3	6.4 ± 1	-	-
16:3n4	-	1.2 ± 0.2	3.3 ± 0.1	4.5 ± 0.8	-	-
LA	6.4 ± 1.1	6.8 ± 0.3	12.7 ± 2.1	14 ± 1.7	2 ± 0.3	2.3 ± 0.4
ALA	4.1 ± 1	2.6 ± 0.1	5.6 ± 0.4	6.1 ± 0.9	-	-
18:3n4	-	1.1 ± 0.1	2.4 ± 0.1	1.8 ± 0.3	-	-
18:3n6	-	-	-	1.2 ± 0.2	-	-
SDA	10.2 ± 3.2	4.2 ± 0.4	13 ± 1	16.2 ± 2.9	1.3 ± 0.1	-
20:2n6	-	-	2.4 ± 0.3	2 ± 0.3	-	-
20:3n3	-	-	1.1 ± 0.1	-	-	-
20:3n6	-	-	-	1.1 ± 0.1	-	-
20:4n3	2.6 ± 0.5	2.5 ± 0.3	5.2 ± 0.7	4.2 ± 0.7	1.1 ± 0.1	1.1 ± 0.1
ARA	9.9 ± 0.5	20.1 ± 0.5	21.6 ± 1.2	15.9 ± 1.3	13.6 ± 1	18.4 ± 2.6
EPA	73.8 ± 7	82.9 ± 3	122.7 ± 5.2	115.9 ± 15.1	55.5 ± 4.2	68.6 ± 10
22:2n6	-	-	-	-	-	-
22:4n6	-	1.8 ± 0	3.3 ± 0.3	-	-	-
DPAn-3	6 ± 0.4	14.7 ± 0.3	17.6 ± 1.3	16 ± 3.6	7 ± 0.6	7.1 ± 0.8
DHA	201.1 ± 8.3	160.2 ± 2	232.7 ± 8.5	212.2 ± 12.1	110.3 ± 7.6	157.5 ± 14.5
Σ (n-3) FA	297.8	267.1	397.9	370.7	175.1	234.3
Σ (n-6) FA	16.3	28.7	39.9	34.0	15.6	20.7
Σ PUFA	315.4	300.2	448.2	417.4	190.7	255.1
mg EPA + DHA in 8 oz	623.5	551.4	806.0	744.1	376.0	512.8
oz to 1750 mg EPA + DHA	22.49	25.40	17.39	18.88	37.34	27.47

Common name *Latin name*	Cod, Sablefish *Anoplopona fimbria*				Croaker, Atlantic *Micropogonias undulatus*
Vendor Date Farm/Wild	NW1 Oct 2012 Wild	NW1 Mar 2013 Wild	SW1 Aug 2012 Wild	SW1 Apr 2013 Wild	MA1 Apr 2013 Wild
Location	Pacific Ocean, USA	Pacific Ocean, USA	California, USA	Pacific Ocean, USA	Atlantic Ocean, USA
Fish 1	22 in, 2.5 lbs	15 in, 3.5 lbs	n/a	15 in, 5 lbs	10 in, 0.54 lbs
Fish 2	21 in, 2.3 lbs	18 in, 4 lbs	n/a	13 in, 4 lbs	10 in, 0.52 lbs
Fish 3	22.4 in, 2.6 lbs	19 in, 4.2 lbs	n/a	12 in, 4 lbs	10.25 in, 0.54 lbs
Moisture (%)	68.17 ± 0.27	74.10 ± 0.47	70.35 ± 0.61	77.26 ± 1.22	83.33 ± 0.03
Total Fat (%)	19.59 ± 1.35	15.71 ± 0.36	16.50 ± 0.50	10.66 ± 0.95	0.91 ± 0.07
Mercury (ppb)	77.55 ± 6.38	281.43 ± 14.12	842.62 ± 19.12	1140.02 ± 77.47	120.66 ± 8.91
<u>FA (mg/100 g)</u>					
12:0	11.5 ± 0.3	7.3 ± 0	7.1 ± 0.3	4.4 ± 0.4	-
14:0	647.2 ± 14.2	330.7 ± 7.4	450.8 ± 33.8	290.3 ± 10.5	5 ± 0.2
16:0	2972.3 ± 44	2490.9 ± 73.4	2408.5 ± 188.6	1796.9 ± 33.7	99.3 ± 3
18:0	420 ± 2.5	442.4 ± 36.6	484.5 ± 40.9	364.1 ± 22.3	40.4 ± 4.5
20:0	18.6 ± 0.1	17.8 ± 0.6	28.4 ± 2.9	21.3 ± 2.3	1.4 ± 0.2
22:0	7.9 ± 0.3	6.5 ± 0.6	12.6 ± 1.8	8.1 ± 0.7	-
24:0	4.2 ± 0	4.9 ± 0.4	8.1 ± 0.7	6.6 ± 0.8	1.2 ± 0.2
Σ SFA	4081.6	3300.5	3400.0	2491.7	147.2
14:1n5	20.5 ± 0.2	16.7 ± 0.3	25.3 ± 1.4	15.6 ± 0.1	-
16:1n7	1385.8 ± 38.8	1153.3 ± 27.1	1368 ± 96.8	893.2 ± 5.7	23.2 ± 1.4
18:1n7	965.3 ± 13.9	942.3 ± 71.4	1082.7 ± 87.6	713 ± 31.8	15 ± 2.4
18:1n9	4762.8 ± 51.2	4463.9 ± 378.5	4946.1 ± 385.7	3723.1 ± 141.4	43.3 ± 5.9
20:1n9	513.5 ± 14.8	273.8 ± 7.7	743.1 ± 54.4	566.1 ± 28.8	4.1 ± 0.6
22:1n9	75.3 ± 0.3	83.6 ± 2.9	159.9 ± 12.9	111.8 ± 8.1	-
24:1n9	46.2 ± 5.4	89 ± 3.8	167.5 ± 14.8	144 ± 12.9	1.7 ± 0.2
Σ MUFA	7769.4	7022.6	8492.7	6166.7	87.2
16:2n4	91.9 ± 3.3	52 ± 0.2	36.5 ± 2.9	17.9 ± 0.1	-
16:3n4	54.6 ± 1.8	20.9 ± 0.1	15.6 ± 1.4	4.3 ± 0.3	-
LA	153.4 ± 3.5	120.7 ± 2.2	131 ± 10.4	91.1 ± 0.2	5 ± 0.5
ALA	100 ± 2.6	59 ± 1.1	53.1 ± 5	32 ± 0.7	1 ± 0.1
18:3n4	27.6 ± 0.3	18.4 ± 0.1	31.1 ± 4.5	18 ± 0.5	1.1 ± 0.1
18:3n6	14 ± 0.9	8.1 ± 0.1	7.5 ± 0.7	4 ± 0.2	-
SDA	235.5 ± 6.1	82.5 ± 0.1	64 ± 6.3	27.4 ± 0.1	-
20:2n6	23.1 ± 0.6	20.8 ± 0.3	38.6 ± 3.5	22.2 ± 0.8	2.4 ± 0.4
20:3n3	13.1 ± 0.5	12.8 ± 1.1	20.1 ± 3	11.5 ± 0.1	-
20:3n6	8.6 ± 0.1	6.6 ± 0.1	9.3 ± 0.9	5.3 ± 0.3	1.5 ± 0.2
20:4n3	94.1 ± 2.7	39.2 ± 0.2	37.9 ± 5.2	25.4 ± 1.5	2 ± 0.3
ARA	93.5 ± 2.5	92.4 ± 2.5	133.7 ± 12.7	88.5 ± 0.1	33.3 ± 2.3
EPA	1423.3 ± 38.3	565.8 ± 6.1	400.2 ± 41.5	222.2 ± 15.4	51.5 ± 3.1
22:2n6	2.4 ± 0.4	3.1 ± 0	7.7 ± 0.1	3.9 ± 0.1	-
22:4n6	19.9 ± 0.8	14.2 ± 1.3	26.3 ± 2.7	13.8 ± 1.5	10 ± 0.8
DPAn-3	168.5 ± 4.8	164.8 ± 5.3	109.4 ± 14.1	58.5 ± 4.2	28.6 ± 3.8
DHA	1137.4 ± 18.8	405.7 ± 11.5	374.6 ± 43.5	346.4 ± 17.5	126.1 ± 15.4
Σ (n-3) FA	3171.9	1329.7	1059.2	723.4	209.1
Σ (n-6) FA	314.9	265.9	354.1	228.9	52.2
Σ PUFA	3660.9	1687.0	1496.5	992.5	262.4
mg EPA + DHA in 8 oz	5807.6	2203.4	1757.3	1289.5	402.6
oz to 1750 mg EPA + DHA	2.41	6.36	8.02	10.88	34.97

Common name *Latin name*	Croaker, Atlantic *Micropogonias undulatus*				Flatfish, American Plaice *Hippoglossoides platessoides*
Vendor Date Farm/Wild	SE1 Dec 2012 Wild	SE1 Aug 2013 Wild	MA2 July 2013 Wild	MA3 June 2013 Wild	NE2 Nov 2012 Wild
Location	Gulf of Mexico, USA	Gulf of Mexico, USA	Chesapeaeke Bay, USA	Chesapeaeke Bay, USA	Gulf of Maine, USA
Fish 1	*8 in	13 in	10 in, 0.8 lbs	11.5 in, 0.8 lbs	*<3 lbs
Fish 2	*10 in	11.5 in	9 in, 0.7 lbs	12.5 in, 1.05 lbs	*<3 lbs
Fish 3	--	13 in	9 in, 0.7 lbs	12.5 in, 1 lb	*<3 lbs
Moisture (%)	79.98 ± 0.19	74.47 ± 0.04	73.38 ± 1.25	73.42 ± 0.22	81.87 ± 0.37
Total Fat (%)	1.93 ± 0.22	7.14 ± 0.29	4.97 ± 0.41	7.11 ± 0.44	1.22 ± 0.12
Mercury (ppb)	140.65 ± 10.40	103.98 ± 7.14	107.28 ± 9.94	72.42 ± 3.45	46.20 ± 3.56
FA (mg/100 g)					
12:0	-	3.4 ± 0.2	3.6 ± 0.3	3.5 ± 0.1	-
14:0	10.3 ± 1.4	132.8 ± 5	123.3 ± 13.9	185.9 ± 8.3	59 ± 9.7
16:0	273.5 ± 33	1672.5 ± 47.9	1291.8 ± 139.5	1959.5 ± 84.1	141.8 ± 12.7
18:0	73.4 ± 8.1	323.4 ± 9.1	255.5 ± 27.1	390.6 ± 35.8	38 ± 2.8
20:0	2.8 ± 0.4	16.5 ± 0.7	9.6 ± 1.1	-	1.8 ± 0.2
22:0	1.4 ± 0.1	7.2 ± 0	5 ± 0.7	3.7 ± 0.2	-
24:0	1.5 ± 0	4.2 ± 0.3	3 ± 0.3	3 ± 0.2	-
Σ SFA	362.8	2160.2	1691.9	2546.3	240.6
14:1n5	-	7.8 ± 0.1	5.2 ± 0.6	8.5 ± 0.3	-
16:1n7	123.1 ± 17.6	901 ± 32.7	637.9 ± 79.3	1055.6 ± 55.6	30 ± 3.4
18:1n7	30.1 ± 4.3	194.2 ± 6.6	135.8 ± 17.2	190.2 ± 8	23.4 ± 1.7
18:1n9	135.7 ± 19.6	970.4 ± 30.2	748.8 ± 84.5	1206.8 ± 50.2	69.2 ± 2
20:1n9	11 ± 1.8	46.1 ± 0.8	42.8 ± 5.7	58.5 ± 2.7	44.6 ± 5.9
22:1n9	2.5 ± 0.4	10.8 ± 0.6	9.1 ± 1	9.4 ± 0.2	9.1 ± 1.3
24:1n9	-	8.2 ± 0.5	7.2 ± 0.4	5.7 ± 0.4	4.5 ± 0.7
Σ MUFA	302.4	2138.6	1586.7	2534.7	180.8
16:2n4	-	17.3 ± 1.4	13 ± 1.8	16.6 ± 0.9	1.3 ± 0.1
16:3n4	-	5.5 ± 0.4	7.8 ± 0.8	6.5 ± 0.4	-
LA	8.1 ± 1.2	45.8 ± 0.8	50.8 ± 5.6	32.1 ± 1.2	9.4 ± 0.7
ALA	2.1 ± 0.3	28.3 ± 0.7	27.7 ± 4	23.8 ± 0.8	4 ± 0.2
18:3n4	2.6 ± 0.4	9.9 ± 0.6	7.9 ± 1.3	12.6 ± 1.2	2.7 ± 0.2
18:3n6	-	5.4 ± 0.3	3.6 ± 0.5	4.9 ± 0.6	-
SDA	-	36.5 ± 1.4	52.5 ± 6	39.9 ± 1.8	5.6 ± 0.4
20:2n6	5.1 ± 0.7	21.7 ± 0.4	19.6 ± 2.9	25 ± 1.1	2.6 ± 0.2
20:3n3	1.2 ± 0.3	7.8 ± 0.1	7.8 ± 0.8	11.9 ± 0.4	2 ± 0.3
20:3n6	1.9 ± 0.2	7.1 ± 3.4	5.6 ± 1.1	8.6 ± 0.6	-
20:4n3	1.8 ± 0.3	60.5 ± 2.1	31.3 ± 3.7	38.7 ± 1.7	4.1 ± 0.3
ARA	57.4 ± 4.2	76.2 ± 1.6	78.3 ± 7	70 ± 1.2	31.6 ± 1.6
EPA	51.6 ± 4.6	312.7 ± 14.3	296.5 ± 32.1	321.7 ± 9.3	116.2 ± 5.2
22:2n6	-	2 ± 0.5	1.4 ± 0.2	1.7 ± 0.1	-
22:4n6	23.8 ± 2.7	38.7 ± 2.5	30.6 ± 4.3	30 ± 0.4	3.6 ± 0.1
DPAn-3	40.1 ± 4.6	154.9 ± 8.2	127.8 ± 14.4	178.2 ± 4.5	18.6 ± 0.9
DHA	164.2 ± 11.4	419.7 ± 11.8	374.3 ± 38.4	352.1 ± 6.6	102.8 ± 4.9
Σ (n-3) FA	261.0	1020.3	917.9	966.4	253.2
Σ (n-6) FA	96.3	196.8	189.9	172.3	47.1
Σ PUFA	359.8	1250.0	1136.5	1174.4	304.4
mg EPA + DHA in 8 oz	489.4	1661.0	1521.2	1528.2	496.6
oz to 1750 mg EPA + DHA	28.69	8.44	9.26	9.17	28.22

Common name	Flatfish, American Plaice	Flatfish, English Sole		Flatfish, Grey Sole	
Latin name	*Hippoglossoides platessoides*	*Parophrys vetulus*		*Glyptocephalus cynoglossus*	
Vendor	NE4	NW1	NW1	NE2	NE4
Date	Apr 2013	Sept 2012	Apr 2013	Nov 2012	May 2013
Farm/Wild	Wild	Wild	Wild	Wild	Wild
Location	Gulf of Maine, USA	Pacific Ocean, USA	Pacific Ocean, USA	Gulf of Maine, USA	North Atlantic Ocean, USA
Fish 1	17 in, 3.25 lbs	n/a	*10 in, *0.7 lbs	n/a	18 in, 1.2 lbs
Fish 2	16.5 in, 2.6 lbs	n/a	*12 in, *0.8 lbs	n/a	14 in, 1.1 lbs
Fish 3	15.5 in, 2.35 lbs	n/a	*11 in, *0.6 lbs	n/a	13 in, 1.05 lbs
Moisture (%)	78.01 ± 0.85	80.86 ± 0.07	74.08 ± 3.00	84.76 ± 0.51	84.14 ± 0.11
Total Fat (%)	3.72 ± 0.17	1.44 ± 0.00	1.03 ± 0.32	0.63 ± 0.07	0.76 ± 0.14
Mercury (ppb)	26.43 ± 1.24	87.08 ± 2.01	241.36 ± 6.84	37.62 ± 3.03	48.91 ± 3.41
<u>FA (mg/100 g)</u>					
12:0	-	-	-	-	-
14:0	339.2 ± 12.3	44.6 ± 1.1	20.9 ± 3.4	5.2 ± 0.5	8.9 ± 6.2
16:0	380.1 ± 17.9	209.2 ± 1.8	107.8 ± 8.9	75.2 ± 3.3	80.9 ± 18.8
18:0	65.9 ± 3.6	46.1 ± 0.2	28.1 ± 1.5	20.8 ± 0.6	24.1 ± 5.6
20:0	7.4 ± 0.5	1.3 ± 0.1	1.3 ± 0.3	-	-
22:0	2.1 ± 0.2	-	-	-	2.7 ± 0.1
24:0	-	-	-	-	-
Σ SFA	794.7	301.2	158.2	101.2	116.6
14:1n5	3.3 ± 0.1	1.5 ± 0.1	-	-	-
16:1n7	175 ± 8.2	63.9 ± 0.2	41.8 ± 7.9	12.7 ± 2	11.3 ± 7.4
18:1n7	71.5 ± 4.2	59.9 ± 0.9	33.6 ± 5.3	16.5 ± 2.1	17.5 ± 8.4
18:1n9	360.3 ± 21	162.2 ± 0.3	73.6 ± 10.2	20.1 ± 1.2	23.3 ± 9.1
20:1n9	298.6 ± 34.1	23.3 ± 0.5	14.5 ± 2.5	4.6 ± 0.3	7.4 ± 4.8
22:1n9	455.4 ± 31.9	4 ± 0	5.4 ± 1.3	-	-
24:1n9	19.1 ± 1.3	4.8 ± 2.4	6 ± 1.2	1.8 ± 0.1	1.8 ± 0.4
Σ MUFA	1383.3	319.7	175.0	55.7	61.4
16:2n4	6.5 ± 1.3	9.2 ± 0.4	2.3 ± 0.5	-	-
16:3n4	1.3 ± 0	3.1 ± 1.1	-	-	-
LA	37.2 ± 1.9	7.8 ± 0.1	5.8 ± 0.8	3 ± 0.1	3.2 ± 0.9
ALA	20.8 ± 1.3	3.9 ± 0	2.5 ± 0.5	-	-
18:3n4	7.9 ± 0.4	1.9 ± 0	1.7 ± 0.4	1.3 ± 0.1	-
18:3n6	-	-	-	-	-
SDA	14.5 ± 0.8	8.3 ± 0.2	4.5 ± 1.1	-	-
20:2n6	9.4 ± 0.9	2.6 ± 0.1	2.7 ± 0.6	2 ± 0.2	2.2 ± 1
20:3n3	9.9 ± 0.5	1.5 ± 0.1	-	-	-
20:3n6	-	-	-	-	-
20:4n3	11.7 ± 0.6	3.9 ± 0.1	2.4 ± 0.6	1.2 ± 0.1	-
ARA	46.9 ± 2.5	25.7 ± 0.5	23.2 ± 1.3	30.1 ± 0.5	29.7 ± 1.9
EPA	203.6 ± 11.2	165.6 ± 1	95.2 ± 12.2	58.2 ± 2.3	60.1 ± 12.2
22:2n6	2.7 ± 0.3	-	-	-	-
22:4n6	4.5 ± 1.3	4.2 ± 0.1	5.7 ± 1.2	10.1 ± 0.3	9.3 ± 1.3
DPAn-3	39 ± 1.9	31.3 ± 0.7	26.3 ± 4.1	18.7 ± 0.8	20 ± 3.1
DHA	149.2 ± 7.9	159.6 ± 2.3	101.2 ± 5.3	79.8 ± 0.6	77.9 ± 9.8
Σ (n-3) FA	448.7	374.0	232.2	157.9	157.9
Σ (n-6) FA	100.6	40.2	37.4	45.1	44.4
Σ PUFA	565.1	428.4	273.5	204.3	202.4
mg EPA + DHA in 8 oz	800.2	737.5	445.5	313.0	312.9
oz to 1750 mg EPA + DHA	17.53	18.99	31.56	44.74	45.32

Common name Latin name	Flatfish, Gulf Flounder *Paralichthys albigutta*		Flatfish, Pacific Dover Sole *Microstomus pacificus*		
Vendor Date Farm/Wild	SE2 Nov 2012 Wild	SE1 Mar 2013 Wild	NW1 Sept 2012 Wild	SW1 Aug 2012 Wild	SW1 Apr 2013 Wild
Location	Gulf of Mexico, USA	Gulf of Mexico, USA	Pacific Ocean, USA	USA	Pacific Ocean, USA
Fish 1	13.75 in, 1.1 lbs	14.5 in	n/a	n/a	n/a
Fish 2	14.5 in, 1.2 lbs	17 in	n/a	n/a	n/a
Fish 3	14.25 in, 1.1 lbs	18 in	n/a	n/a	n/a
Moisture (%)	81.77 ± 0.01	80.90 ± 0.23	86.32 ± 0.17	85.70 ± 0.26	85.21 ± 0.12
Total Fat (%)	0.44 ± 0.07	0.50 ± 0.11	0.59 ± 0.06	1.40 ± 0.21	0.69 ± 0.05
Mercury (ppb)	140.68 ± 10.83	154.98 ± 14.28	123.57 ± 9.58	226.50 ± 4.79	194.23 ± 16.28
FA (mg/100 g)					
12:0	-	-	-	1.1 ± 0.1	-
14:0	1.7 ± 0.3	4 ± 1.7	10.3 ± 1.1	13.5 ± 0.2	8.8 ± 0.7
16:0	49.7 ± 1.8	65 ± 8.6	79.2 ± 8.8	102.3 ± 5	85.5 ± 3.9
18:0	18.9 ± 0.5	21.7 ± 2.6	25.6 ± 2	20.3 ± 1.3	18.5 ± 1.6
20:0	-	1.3 ± 0.3	-	1.1 ± 0	-
22:0	-	-	-	-	-
24:0	-	-	-	1.8 ± 0.6	-
Σ SFA	70.4	92.0	115.1	140.2	112.8
14:1n5	-	-	-	-	-
16:1n7	2.7 ± 0.1	10.4 ± 4.9	20.1 ± 2.7	20.9 ± 0.3	18.1 ± 1.7
18:1n7	3.1 ± 0.1	6 ± 1.7	19.5 ± 2.1	14.4 ± 0.3	17 ± 1
18:1n9	19.1 ± 0.7	22.6 ± 4.8	42.6 ± 2.3	39.6 ± 0.3	39.9 ± 4
20:1n9	-	2.6 ± 0.4	8.6 ± 0.1	9.7 ± 0.1	6.8 ± 0.7
22:1n9	-	-	2.3 ± 0	2.8 ± 0.2	1.6 ± 0.4
24:1n9	-	1.8 ± 0.2	2.1 ± 0.2	4.3 ± 1.7	2.3 ± 0.2
Σ MUFA	24.9	43.4	95.3	91.7	85.6
16:2n4	-	-	6.1 ± 1	-	-
16:3n4	-	-	-	-	-
LA	1.5 ± 0.1	2.6 ± 0.4	4 ± 0.5	4.3 ± 0.2	3.6 ± 0
ALA	-	-	1.4 ± 0.3	-	1.1 ± 0
18:3n4	-	-	1.6 ± 0.2	1.8 ± 0.2	1 ± 0.1
18:3n6	-	-	-	-	-
SDA	-	-	2.2 ± 0.2	2 ± 0	1.3 ± 0.1
20:2n6	-	-	1.8 ± 0.3	1.7 ± 0	1.2 ± 0.1
20:3n3	-	-	-	-	-
20:3n6	-	-	-	-	-
20:4n3	-	-	1.4 ± 0.1	1.6 ± 0	1.3 ± 0
ARA	26.6 ± 0.7	27.5 ± 1.6	21.2 ± 1.4	30.4 ± 2.6	15.5 ± 0.7
EPA	7.6 ± 0.2	12.2 ± 2.9	59.7 ± 6.5	74.4 ± 6.3	64.2 ± 2.3
22:2n6	-	-	-	-	-
22:4n6	3.4 ± 0.3	5.8 ± 0.4	4.6 ± 0.6	9 ± 1.6	5.7 ± 0.6
DPAn-3	5.2 ± 0.3	20.4 ± 3.1	18.4 ± 1.6	17.4 ± 1.6	22.7 ± 1.3
DHA	50.2 ± 1	52.8 ± 5	94.8 ± 6.8	79.3 ± 9.6	79.1 ± 4.1
Σ (n-3) FA	63.1	85.4	178.0	174.8	169.7
Σ (n-6) FA	31.5	35.9	31.6	45.3	26.0
Σ PUFA	94.6	121.3	217.2	221.9	196.7
mg EPA + DHA in 8 oz	131.1	147.4	350.4	348.8	324.9
oz to 1750 mg EPA + DHA	106.80	95.73	40.10	40.37	43.13

Common name	Flatfish, Pacific Dover Sole	Flatfish, Petrale Sole			
Latin name	*Microstomus pacificus*	*Eopsetta jordani*			
Vendor	NW1	NW1	SW1	SW1	NW1
Date	Mar 2013	Sept 2012	Aug 2012	Apr 2013	Mar 2013
Farm/Wild	Wild	Wild	Wild	Wild	Wild
Location	Pacific Ocean, USA	Pacific Ocean, USA	USA	Pacific Ocean, USA	Pacific Ocean, USA
Fish 1	*9 in, *0.98 lbs	12 in, 2.4 lbs	n/a	n/a	*12 in, *1.25 lbs
Fish 2	*10 in, *1.2 lbs	13 in, 2.7 lbs	n/a	n/a	*13 in, *1.5 lbs
Fish 3	*12 in, *1.5 lbs	11.4 in, 2.2 lbs	n/a	n/a	*14 in, *1.65 lbs
Moisture (%)	85.18 ± 0.09	79.29 ± 0.18	80.56 ± 0.08	82.43 ± 0.79	81.97 ± 0.06
Total Fat (%)	1.42 ± 0.03	1.27 ± 0.01	1.49 ± 0.21	1.08 ± 0.05	1.41 ± 0.24
Mercury (ppb)	162.78 ± 3.18	64.37 ± 3.88	117.85 ± 4.99	80.51 ± 5.70	60.95 ± 3.58
FA (mg/100 g)					
12:0	-	-	-	-	-
14:0	19 ± 4.2	23.8 ± 0.3	27 ± 6.3	23.8 ± 2.7	27.7 ± 2.4
16:0	109.1 ± 10.5	167.4 ± 1.4	140.8 ± 24.7	171.3 ± 8.9	175.7 ± 3.7
18:0	38.3 ± 3.2	39.6 ± 0	36.4 ± 5.2	33.5 ± 1.1	34.9 ± 0
20:0	1.8 ± 0.4	1.2 ± 0	1.1 ± 0.2	-	1.3 ± 0
22:0	-	-	-	-	-
24:0	-	-	-	-	-
Σ SFA	168.1	232.0	205.3	228.6	239.7
14:1n5	-	-	-	-	-
16:1n7	25.9 ± 4	52.5 ± 0.9	41.8 ± 12	59.5 ± 9.6	61.3 ± 6.4
18:1n7	32 ± 4.5	35.1 ± 0.1	23.9 ± 4.1	35.8 ± 5.5	36.4 ± 3.4
18:1n9	48.8 ± 4.9	122.1 ± 1.6	76.5 ± 14.9	123.9 ± 24.9	131.2 ± 2.7
20:1n9	10.1 ± 1.8	19.4 ± 0.8	15.8 ± 1.6	14 ± 2.4	21.5 ± 0
22:1n9	2.3 ± 0.5	2.8 ± 0.1	1.9 ± 0.3	2.2 ± 0.5	3.2 ± 0.2
24:1n9	3 ± 0.2	5.1 ± 0.2	4 ± 0.8	4 ± 1	5.2 ± 0.2
Σ MUFA	122.1	236.9	163.9	239.3	258.8
16:2n4	1.1 ± 0.1	3.3 ± 0.1	3 ± 0.6	3.5 ± 0.7	4.2 ± 0.5
16:3n4	-	2 ± 0.1	2.4 ± 0.5	2.4 ± 0.4	3 ± 0.4
LA	6.6 ± 1.8	6.7 ± 0.2	6.8 ± 1	6.9 ± 0.9	8 ± 0.6
ALA	2.4 ± 0.1	3.3 ± 0	3.2 ± 0.4	3.3 ± 0.6	3.8 ± 0.5
18:3n4	1.6 ± 0.2	1.1 ± 0.1	1.7 ± 0.4	-	1.2 ± 0
18:3n6	-	-	-	-	-
SDA	3.7 ± 0.8	7.3 ± 0.3	7.9 ± 1.2	7.5 ± 1.5	9 ± 1.2
20:2n6	2.7 ± 0.2	1.3 ± 0	1.1 ± 0.2	1.4 ± 0.2	1.5 ± 0.1
20:3n3	1.3 ± 0.2	-	-	-	-
20:3n6	1.2 ± 0.1	-	-	-	-
20:4n3	3.1 ± 0.5	2.8 ± 0.2	3.4 ± 0.4	2.6 ± 0.5	3.2 ± 0.3
ARA	30.8 ± 2.4	13.8 ± 0.7	15.6 ± 1.4	15.7 ± 0.3	16.2 ± 0.9
EPA	80.1 ± 10.2	95.7 ± 7.8	92.5 ± 9.6	101.5 ± 8.2	117.9 ± 7.6
22:2n6	-	-	-	-	-
22:4n6	9 ± 1.3	1.4 ± 0.1	2.3 ± 0.4	1.1 ± 0	1.4 ± 0.3
DPAn-3	28 ± 3.3	27.4 ± 1.6	29.3 ± 2.9	34 ± 4.3	34.9 ± 3.1
DHA	107.7 ± 7	164 ± 19.7	180.8 ± 13.4	186 ± 5.9	188 ± 6.6
Σ (n-3) FA	226.3	300.5	317.1	335.0	356.8
Σ (n-6) FA	50.4	23.1	25.7	25.1	27.1
Σ PUFA	279.3	330.0	349.9	366.0	392.4
mg EPA + DHA in 8 oz	426.0	589.1	619.8	652.2	693.7
oz to 1750 mg EPA + DHA	33.00	23.90	22.67	21.50	20.21

Common name *Latin name*	Flatfish, Rex Sole *Glyptocephalus zachirus*		Flatfish, Southern Flounder *Paralichthys lethostigma*	Flatfish, Summer Flounder *Paralichthys dentatus*	
Vendor	NW1	NW1	SE2	MA1	GL1
Date	Sept 2012	Mar 2013	June 2013	Apr 2013	Nov 2010
Farm/Wild	Wild	Wild	Wild	Wild	Wild
Location	Pacific Ocean, USA	Pacific Ocean, USA	Gulf of Mexico, USA	Atlantic Ocean, USA	Atlantic Ocean
Fish 1	14 in, 1 lb	*8 in, *0.7 lbs	17.5 in, 3.5 lbs	14.5 in, 1.41 lbs	17 in, 3.25 lbs
Fish 2	13.5 in, 1.2 lbs	*8 in, *0.5 lbs	16.5 in, 2.75 lbs	12.5 in, 1.29 lbs	13 in, 3.2 lbs
Fish 3	14.2 in, 1.1 lbs	7 in, 0.8 lbs	17 in, 3 lbs	14.5 in, 1.55 lbs	22 in, 3.8 lbs
Moisture (%)	83.34 ± 0.13	83.81 ± 0.15	80.18 ± 0.02	79.45 ± 0.34	79.14 ± 0.24
Total Fat (%)	0.51 ± 0.03	0.91 ± 0.16	0.38 ± 0.05	1.23 ± 0.01	0.90 ± 0.21
Mercury (ppb)	111.29 ± 2.45	275.74 ± 19.83	246.05 ± 20.95	137.04 ± 4.60	141.17 ± 5.13
FA (mg/100 g)					
12:0	-	-	-	-	-
14:0	7.9 ± 0.5	10.8 ± 1.4	4 ± 1.4	29.5 ± 2.9	16.7 ± 1.9
16:0	91.6 ± 4.8	114.6 ± 7.5	67.4 ± 9.5	191.7 ± 11.7	126.7 ± 3.9
18:0	21.8 ± 0.1	32.9 ± 0.6	24.9 ± 3.6	51.8 ± 3.5	28.6 ± 0.3
20:0	-	-	-	2.3 ± 0.2	-
22:0	-	-	-	1.2 ± 0	-
24:0	-	-	-	-	-
Σ SFA	121.3	158.3	96.3	276.5	172.0
14:1n5	-	-	-	-	-
16:1n7	15.9 ± 2.3	22.4 ± 3.3	7.2 ± 3.1	47.4 ± 4.4	17.8 ± 1.6
18:1n7	16.7 ± 0.4	25.5 ± 2	6.1 ± 1.7	30.4 ± 3.1	11.6 ± 0.6
18:1n9	29.6 ± 1.2	40.3 ± 0.4	29.6 ± 7.4	135.6 ± 12	54.9 ± 3.8
20:1n9	6.7 ± 0.2	10.1 ± 0.4	-	16.7 ± 1.4	18.5 ± 2
22:1n9	-	2.1 ± 0.1	-	3.5 ± 0.3	2.1 ± 0.2
24:1n9	1.5 ± 0.2	3.4 ± 0	2.1 ± 0.7	5.8 ± 0.1	3.5 ± 0.3
Σ MUFA	70.4	103.8	45.0	239.3	108.4
16:2n4	-	2.1 ± 0.4	-	1.9 ± 0.3	-
16:3n4	-	-	-	1.3 ± 0.3	-
LA	3.7 ± 0.2	7.4 ± 0.8	2.7 ± 0.5	5.6 ± 0.6	5.8 ± 0.3
ALA	-	1.8 ± 0.1	-	2.1 ± 0.3	2.1 ± 0.2
18:3n4	1.2 ± 0.2	1.6 ± 0	-	2.7 ± 0.4	1.3 ± 0
18:3n6	-	-	-	-	-
SDA	1.8 ± 0	3.1 ± 0.5	-	3.3 ± 0.3	3.3 ± 0.5
20:2n6	2 ± 0.1	3.1 ± 0.1	-	3.1 ± 0.4	1.2 ± 0
20:3n3	-	1.1 ± 0.1	-	1.5 ± 0.2	-
20:3n6	-	-	-	1.1 ± 0.1	-
20:4n3	1.4 ± 0	1.6 ± 0.2	-	2.9 ± 0.5	2.4 ± 0.2
ARA	20.4 ± 0.7	20 ± 0.1	31 ± 2.6	28.6 ± 2.5	14.6 ± 0.2
EPA	71.3 ± 2.2	92.5 ± 5.4	13.3 ± 2.1	53.5 ± 6.6	29.2 ± 1.7
22:2n6	-	-	-	-	-
22:4n6	5.2 ± 0.2	4.6 ± 0	5.5 ± 1	9 ± 1.3	1.4 ± 0
DPAn-3	15.2 ± 0.6	21.8 ± 0.1	12.1 ± 0.8	51.2 ± 7	19.7 ± 0.9
DHA	102.4 ± 2.8	112.3 ± 0.2	73 ± 10.5	195.5 ± 21.5	149.9 ± 5.7
Σ (n-3) FA	192.0	234.2	98.4	310.0	206.6
Σ (n-6) FA	31.4	35.1	39.2	47.4	22.9
Σ PUFA	224.6	273.0	137.6	363.4	230.8
mg EPA + DHA in 8 oz	393.8	464.5	195.7	564.8	406.3
oz to 1750 mg EPA + DHA	35.57	30.15	72.30	24.95	34.49

Common name	Flatfish, Summer Flounder			Flatfish, Winter Flounder	Flatfish, Yellowtail Flounder
Latin name	*Paralichthys dentatus*			*Pseudopleuronectes americanus*	*Limanda ferruginea*
Vendor	GL1	MA2	MA3	NE1	NE1
Date	Aug 2012	July 2013	June 2013	Nov 2012	Nov 2012
Farm/Wild	Wild	Wild	Wild	Wild	Wild
Location	Massachusetts, USA	Atlantic Ocean, USA	Atlantic Ocean, USA	Cape Cod Bay, USA	Cape Cod Bay, USA
Fish 1	13.5 in, 1.84 lbs	n/a	14.25 in, 1 lbs	12 in, 1.3 lbs	11.5 in, 0.9 lbs
Fish 2	15.5 in, 3.12 lbs	n/a	15.5 in, 1.25 lbs	10.5 in, 1.35 lbs	11.5 in, 0.95 lbs
Fish 3	15 in, 2.26 lbs	n/a	16 in, 1.6 lbs	10 in, 0.95 lbs	10.5 in, 0.7 in
Moisture (%)	80.59 ± 0.03	79.6 ± 0.04	79.44 ± 0.12	79.38 ± 0.33	80.57 ± 0.06
Total Fat (%)	0.80 ± 0.03	0.52 ± 0.02	0.81 ± 0.17	1.38 ± 0.06	0.89 ± 0.06
Mercury (ppb)	83.85 ± 6.50	76.77 ± 3.42	75.81 ± 5.48	62.67 ± 2.97	28.93 ± 0.55
FA (mg/100 g)					
12:0	-	-	-	-	-
14:0	5.7 ± 1.2	6 ± 0.9	9.9 ± 0.6	37.3 ± 2.5	17.2 ± 0.4
16:0	86.4 ± 13	92.9 ± 12.4	117.7 ± 5	172.2 ± 7.5	103.7 ± 5.4
18:0	25.9 ± 2.8	26.5 ± 2.4	30.1 ± 1.4	41.1 ± 0.6	28.2 ± 0.6
20:0	-	-	-	1.3 ± 0.1	-
22:0	-	-	-	-	-
24:0	-	-	-	-	-
Σ SFA	118.1	125.4	157.8	251.9	149.0
14:1n5	-	-	-	1.1 ± 0.1	-
16:1n7	9.4 ± 1.7	7.3 ± 1	12.8 ± 1.6	72.8 ± 7.1	27.5 ± 2.4
18:1n7	7.6 ± 0.9	7.6 ± 0.8	9.7 ± 1.1	48.2 ± 4	26.2 ± 1.1
18:1n9	32.9 ± 4	26.9 ± 2.9	40.4 ± 5.4	96.9 ± 7.4	47.1 ± 0.4
20:1n9	3.6 ± 0.1	5.2 ± 0.5	8.5 ± 0.6	13.4 ± 1.9	5.7 ± 0.5
22:1n9	-	-	1.4 ± 0.3	2.5 ± 0.1	1 ± 0.1
24:1n9	1.2 ± 0.2	2.9 ± 0.1	3 ± 0.7	2.2 ± 0.4	1.7 ± 0
Σ MUFA	54.6	50.0	75.7	237.2	109.4
16:2n4	2.3 ± 0.1	-	-	1.6 ± 0	4.3 ± 0.5
16:3n4	2.1 ± 0.3	-	-	1.3 ± 0.1	1.3 ± 0.1
LA	2.6 ± 0.3	2.4 ± 0.3	2.5 ± 0.1	12.7 ± 1.5	6.5 ± 0
ALA	-	-	-	8.3 ± 1.2	2.8 ± 0.4
18:3n4	1 ± 0	-	1.1 ± 0.1	3.8 ± 0.9	2.4 ± 0.2
18:3n6	-	-	-	-	-
SDA	-	1.4 ± 0.2	2 ± 0.3	34.6 ± 9.6	16.2 ± 3.5
20:2n6	-	-	-	8.1 ± 1.5	3.7 ± 0.4
20:3n3	-	-	-	4.1 ± 1	1.7 ± 0.3
20:3n6	-	-	-	1.3 ± 0.1	-
20:4n3	-	1.1 ± 0.1	2.2 ± 1.3	10.3 ± 2.4	6.4 ± 0.6
ARA	19.9 ± 1.6	13.9 ± 1.2	20.4 ± 4.3	36.7 ± 1.3	17 ± 0.3
EPA	18.3 ± 1.3	18.3 ± 2	29.6 ± 1.8	179.2 ± 36.7	120.1 ± 2.2
22:2n6	-	-	-	-	-
22:4n6	4.1 ± 0.2	1.7 ± 0.2	2.4 ± 0.4	8.2 ± 1.8	4.8 ± 0.3
DPAn-3	17.1 ± 0.7	18.2 ± 2	24 ± 0.7	36.3 ± 6.2	24.3 ± 0.9
DHA	117.5 ± 3.8	147.3 ± 13.5	170.7 ± 3.7	194.4 ± 37.5	132.4 ± 0.2
Σ (n-3) FA	152.9	186.3	228.5	467.3	303.8
Σ (n-6) FA	26.6	17.9	25.3	66.9	32.1
Σ PUFA	184.9	204.3	254.9	540.9	343.9
mg EPA + DHA in 8 oz	308.0	375.6	454.3	847.4	572.5
oz to 1750 mg EPA + DHA	45.50	37.44	30.83	16.85	24.46

Common name	Flatfish, Yellow-tail Flounder	Grouper (unspecified)			Grouper, Gag	
Latin name	*Limanda ferruginea*	*Epiniphelus spp.*			*Mycteroperca microlepis*	
Vendor	NE2	NE1	NE5	SW1	SE1	SE2
Date	May 2013	Dec 2012	June 2013	Mar 2013	Sept 2012	June 2013
Farm/Wild	Wild	Wild	Wild	Wild	Wild	Wild
Location	Gulf of Maine, USA	El Salvador	Gulf of Mexico, Mexico	USA	Gulf of Mexico, USA	Gulf of Mexico, USA
Fish 1	n/a	n/a	n/a	n/a	*12 lbs	31.5 in, 10 lbs
Fish 2	n/a	n/a	n/a	n/a	*12 lbs	30.5 in, 9.8 lbs
Fish 3	n/a	n/a		n/a	*12 lbs	34.5 in, 14 lbs
Moisture (%)	84.22 ± 0.29	79.78 ± 0.10	78.36 ± 1.62	80.46 ± 0.28	80.32 ± 0.16	78.85 ± 0.48
Total Fat (%)	0.70 ± 0.04	0.97 ± 0.03	1.99 ± 0.08	1.07 ± 0.02	0.56 ± 0.03	0.52 ± 0.01
Mercury (ppb)	59.34 ± 4.29	74.23 ± 5.60	365.37 ± 19.44	165.64 ± 9.49	541.71 ± 26.14	476.86 ± 13.59
FA (mg/100 g)						
12:0	-	-	-	-	-	-
14:0	12.1 ± 1.6	16.8 ± 2.9	67.6 ± 3.1	33.8 ± 2.6	4.2 ± 1.6	4.2 ± 0.7
16:0	83.6 ± 5.4	132.6 ± 9.4	389.4 ± 9	190.7 ± 7.3	71.3 ± 4.4	68 ± 0.4
18:0	23.3 ± 0.8	45.3 ± 0.8	110.4 ± 1.2	51.7 ± 2.5	35.9 ± 0.7	33.3 ± 0.8
20:0	-	2.4 ± 0.2	5.6 ± 0.1	1.9 ± 0.2	-	-
22:0	-	1.3 ± 0.1	2.8 ± 0.1	1 ± 0	-	-
24:0	-	1.3 ± 0.4	1.8 ± 0.1	-	-	-
Σ SFA	119.0	199.7	577.7	279.2	111.4	105.6
14:1n5	-	-	1.1 ± 0.2	-	-	-
16:1n7	17.4 ± 2.5	28.2 ± 2.8	134.1 ± 3.8	60.9 ± 4.6	7.5 ± 1.8	11.4 ± 0.8
18:1n7	15.8 ± 0.8	12.3 ± 0.8	60.8 ± 1.2	24.7 ± 2.5	7 ± 0.6	7.3 ± 0.2
18:1n9	42.6 ± 3.2	65.6 ± 3	367.4 ± 4.5	163.7 ± 15.5	44.2 ± 3.7	40.1 ± 1.5
20:1n9	15.7 ± 1.1	6 ± 0.5	39.2 ± 0.8	15.5 ± 2.6	2 ± 0.4	2.2 ± 0
22:1n9	5.7 ± 1	3.7 ± 0.4	7.4 ± 0.3	3.7 ± 0.2	-	-
24:1n9	3.5 ± 0.2	3.8 ± 1.5	9.7 ± 0	4.6 ± 0.6	1.6 ± 0.1	2.3 ± 0.1
Σ MUFA	100.7	119.6	619.7	273.2	62.2	63.2
16:2n4	-	-	4.2 ± 0.2	1.9 ± 0.3	2.1 ± 0.2	-
16:3n4	-	-	1.8 ± 0.1	1.1 ± 0.1	1.7 ± 0.2	-
LA	4.3 ± 0.3	5.7 ± 0.1	20.6 ± 0.2	10.6 ± 1.2	3.9 ± 0.1	3.7 ± 0.1
ALA	1.3 ± 0.1	1.2 ± 0.1	9.3 ± 0.1	4.6 ± 0.8	-	-
18:3n4	1.5 ± 0.2	1.3 ± 0	5.7 ± 0	1.6 ± 0.2	-	-
18:3n6	-	-	1.5 ± 0.1	-	-	-
SDA	2.7 ± 0.3	-	6 ± 0.1	3.3 ± 0.8	-	-
20:2n6	1.1 ± 0.1	2.3 ± 0.1	6 ± 0.1	2.5 ± 0.4	1.3 ± 0.1	1 ± 0
20:3n3	-	-	3.8 ± 0	1.2 ± 0.2	-	-
20:3n6	-	1.1 ± 0	3.7 ± 0.1	1.7 ± 0.2	-	-
20:4n3	1.9 ± 0.2	1.6 ± 0.2	11 ± 0.3	4.8 ± 1.1	-	-
ARA	12.4 ± 0.5	29.5 ± 0.8	57.6 ± 2.1	26.6 ± 2.5	33.4 ± 0.5	27.1 ± 1.4
EPA	86.7 ± 2	20.5 ± 0.2	79.9 ± 4.1	38.9 ± 7.3	9.2 ± 0.1	14.3 ± 0.3
22:2n6	-	-	-	-	-	-
22:4n6	-	7.9 ± 0.4	15.2 ± 0.3	7.3 ± 0.3	8.6 ± 0.8	5.5 ± 0.2
DPAn-3	13.4 ± 1.2	17.7 ± 0.4	57.1 ± 2.9	36.9 ± 7.5	9.6 ± 0.9	9.1 ± 0.5
DHA	149.1 ± 7.4	140.1 ± 2.4	261 ± 20.7	134.9 ± 26.4	104.4 ± 0.9	111.5 ± 5.2
Σ (n-3) FA	255.1	181.1	428.1	224.6	123.2	134.9
Σ (n-6) FA	17.9	46.5	104.6	48.7	47.2	37.3
Σ PUFA	274.5	228.9	544.4	277.9	174.2	172.2
mg EPA + DHA in 8 oz	534.7	364.1	773.1	394.1	257.6	285.2
oz to 1750 mg EPA + DHA	26.21	38.45	18.16	36.21	54.35	49.14

Common name *Latin name*	Grouper, Red *Epinephelus morio*				Grouper, Yellowedge *Hyporthodus flavolimbatus*
Vendor Date Farm/Wild	GL1 Oct 2010 Wild	GL1 Aug 2012 Wild	SE3 Oct 2012 Wild	SE2 June 2013 Wild	SE1 May 2013 Wild
Location	Gulf of Mexico, Florida	Gulf of Mexico	Honduras	Gulf of Mexico, Mexico	Gulf of Mexico, USA
Fish 1	19 in, 5.75 lbs	17.5 in, 5.45 lbs	9.5 lbs	24.5 in, 8.5 lbs	21 in
Fish 2	17 in, 5.4 lbs	17.75 in, 4.94 lbs	9.5 lbs	23.5 in, 7.5 lbs	21 in
Fish 3	17 in, 5.45 lbs	18 in, 3.58 lbs	9.5 lbs	25.75 in, 9.7 lbs	20 in
Moisture (%)	79.67 ± 0.45	79.34 ± 0.20	78.74 ± 0.44	80.57 ± 0.20	80.56 ± 0.17
Total Fat (%)	1.26 ± 0.04	1.10 ± 0.05	0.73 ± 0.14	0.73 ± 0.13	0.55 ± 0.02
Mercury (ppb)	237.22 ± 17.68	426.58 ± 16.57	679.09 ± 19.40	912.23 ± 30.92	725.72 ± 53.98
FA (mg/100 g)					
12:0	-	-	-	-	-
14:0	11.2 ± 0	8.1 ± 0.4	15.6 ± 3.6	23.1 ± 7.1	3.9 ± 0.9
16:0	124.1 ± 2.6	92.7 ± 1.1	123.5 ± 12	117 ± 24.5	82.4 ± 2.5
18:0	46.3 ± 0.7	40.9 ± 0.2	45 ± 3.7	44.8 ± 6.7	29.2 ± 0.5
20:0	1.1 ± 0	1.3 ± 0.1	-	2.2 ± 0.5	-
22:0	-	-	-	1.6 ± 0.4	-
24:0	-	1.2 ± 0.1	-	2 ± 0.4	-
Σ SFA	182.7	144.3	184.1	190.7	115.5
14:1n5	-	-	-	-	-
16:1n7	31.3 ± 1.3	19.8 ± 1.2	22.2 ± 5.3	30.5 ± 8.5	11.4 ± 1.8
18:1n7	11.3 ± 0.3	10 ± 0.3	9.8 ± 2.1	15.1 ± 3.2	7.2 ± 0.6
18:1n9	61.1 ± 2.1	57.5 ± 0.7	53.4 ± 4.6	63.2 ± 12.9	46.4 ± 5.1
20:1n9	3.6 ± 0.1	3.3 ± 0.2	3 ± 0.8	6.3 ± 1.6	5.3 ± 0.9
22:1n9	-	-	-	1.5 ± 0.3	-
24:1n9	2.2 ± 0	2.8 ± 0.3	1.8 ± 0.2	4.9 ± 0.8	3 ± 0.6
Σ MUFA	109.5	93.3	90.2	121.4	73.3
16:2n4	-	-	2.1 ± 0.2	-	-
16:3n4	-	-	1.8 ± 0.6	-	-
LA	4.3 ± 0	4.6 ± 0	5.4 ± 1	5.1 ± 0.7	2.7 ± 0.2
ALA	-	-	2 ± 0.5	-	-
18:3n4	1 ± 0	1.2 ± 0	1 ± 0	1.6 ± 0.3	-
18:3n6	-	-	2.3 ± 0.8	-	-
SDA	-	-	3.8 ± 1.5	-	-
20:2n6	1.5 ± 0	1.5 ± 0	1.3 ± 0.3	1.9 ± 0.4	1.2 ± 0.1
20:3n3	-	-	-	-	-
20:3n6	-	1.2 ± 0	2.5 ± 0.6	2.2 ± 0.3	-
20:4n3	1.2 ± 0	1.1 ± 0	1.7 ± 0.6	1.7 ± 0.3	-
ARA	31 ± 1.3	32 ± 0.1	52.5 ± 7	37 ± 2.4	21.4 ± 0.3
EPA	14.8 ± 0.5	11.5 ± 0.2	10.3 ± 3.4	15.9 ± 1.3	11.7 ± 0.5
22:2n6	-	-	-	-	-
22:4n6	8.2 ± 0.2	9.9 ± 0.2	11.5 ± 3	14 ± 2	6.2 ± 0.6
DPAn-3	13.9 ± 0.5	13.9 ± 0.5	7 ± 2.3	27 ± 3.7	12.5 ± 1.2
DHA	111.5 ± 4.1	120.6 ± 1.1	32.9 ± 7.1	82.3 ± 5	122.7 ± 2.3
Σ (n-3) FA	141.5	147.1	57.8	126.9	146.9
Σ (n-6) FA	45.0	49.2	75.6	60.2	31.4
Σ PUFA	187.4	197.5	138.4	188.7	178.4
mg EPA + DHA in 8 oz	286.6	299.6	98.1	222.7	304.9
oz to 1750 mg EPA + DHA	48.88	46.74	146.95	63.00	45.94

Common name *Latin name*	Haddock *Melanogrammus aeglefinus*				Hake, Silver *Merluccius bilinearis*	
Vendor Date Farm/Wild	NE2 Nov 2012 Wild	NE3 Oct 2012 Wild	NE4 May 2013 Wild	NE2 May 2013 Wild	NE2 Nov 2012 Wild	NE4 Apr 2013 Wild
Location	Gulf of Maine, USA	Iceland	Gulf of Maine	Norway	Gulf of Maine, USA	Gulf of Maine
Fish 1	21 in, 6.1 lbs	n/a	20 in, 2.95 lbs	n/a	*28 in, *6 lbs	17 in, 3.1 lbs
Fish 2	21 in, 4 lbs	n/a	17 in, 1.8 lbs	n/a	*30 in, *8 lbs	17.5 in, 3.2 lbs
Fish 3	26 in, 5.3 lbs	n/a	19 in, 2.6 lbs	n/a	*25 in, *4 lbs	16.5 in, 2.65 lbs
Moisture (%)	82.3 ± 0.07	81.67 ± 0.09	82.74 ± 0.14	81.59 ± 0.20	83.27 ± 0.07	82.32 ± 0.02
Total Fat (%)	0.55 ± 0.05	0.50 ± 0.06	0.57 ± 0.03	0.61 ± 0.11	1.03 ± 0.08	0.58 ± 0.01
Mercury (ppb)	40.10 ± 2.17	32.68 ± 0.99	86.58 ± 2.22	92.79 ± 1.75	74.21 ± 1.13	98.10 ± 5.05
FA (mg/100 g)						
12:0	-	-	-	-	-	-
14:0	3.4 ± 0.6	5.4 ± 1.2	3.9 ± 0.2	3.4 ± 0.2	6.2 ± 0.2	2.1 ± 0.1
16:0	84.6 ± 3.6	79.4 ± 5.3	56.7 ± 2.2	82.8 ± 1.7	83.9 ± 9	92.1 ± 2.4
18:0	24.2 ± 0.7	18.7 ± 0.9	17.5 ± 0.6	25.2 ± 0.4	22.6 ± 1.8	27.4 ± 0.4
20:0	-	-	-	-	-	-
22:0	1.1 ± 0.1	-	-	-	-	-
24:0	-	-	-	-	-	-
Σ SFA	113.3	103.5	78.1	111.4	112.7	121.7
14:1n5	-	-	-	-	-	-
16:1n7	5.2 ± 0.3	6.6 ± 2.6	2.8 ± 0	4.4 ± 0	8.1 ± 0.1	3 ± 0
18:1n7	16.6 ± 1	14.7 ± 1.9	12.4 ± 0.3	17.9 ± 1.4	12.4 ± 0.3	7.4 ± 0.1
18:1n9	27.8 ± 1.3	30.8 ± 9.9	16.2 ± 0.4	30.9 ± 2.8	42.3 ± 1.7	27.1 ± 0.5
20:1n9	1.9 ± 0.1	8 ± 1.4	2.7 ± 0	3.2 ± 0.6	20.6 ± 0.8	7.4 ± 0.1
22:1n9	-	-	-	-	-	2.2 ± 0.1
24:1n9	-	2.2 ± 0.1	1.7 ± 0.1	3.4 ± 0	2.1 ± 0.6	2.6 ± 0.1
Σ MUFA	51.5	62.3	35.7	59.9	85.6	49.7
16:2n4	-	-	-	-	-	-
16:3n4	-	-	-	-	-	-
LA	2.3 ± 0.2	3 ± 0.4	2.3 ± 0.1	2.8 ± 0.3	4.7 ± 0.3	3 ± 0.1
ALA	-	1.3 ± 0.3	-	-	1.6 ± 0.1	-
18:3n4	-	-	-	-	-	-
18:3n6	-	-	-	-	-	-
SDA	1.3 ± 0.1	3.1 ± 0.5	1.2 ± 0.1	-	1.8 ± 0	-
20:2n6	1.6 ± 0	-	-	-	-	-
20:3n3	2.6 ± 0.4	-	-	-	-	-
20:3n6	-	-	-	-	-	-
20:4n3	1.6 ± 0.1	2.1 ± 0.2	1.4 ± 0	1.3 ± 0.1	2 ± 0.1	1.2 ± 0
ARA	12.3 ± 0.8	11 ± 0.2	15.2 ± 0.5	16.2 ± 0.6	6.9 ± 0.5	8.6 ± 0.1
EPA	47.9 ± 2.8	65 ± 2.6	80.9 ± 1.5	82.4 ± 0.2	38.1 ± 3	33.2 ± 0.2
22:2n6	5 ± 2.4	-	-	-	-	-
22:4n6	2.2 ± 0.1	1.2 ± 0.1	1.2 ± 0.1	2.1 ± 0.1	-	-
DPAn-3	8.9 ± 0.6	9.4 ± 0.4	8.5 ± 0.5	10.6 ± 0.6	7.1 ± 0.5	7.2 ± 0.3
DHA	115.6 ± 2.3	142.5 ± 3.8	75.3 ± 2.7	105.7 ± 4.9	162.3 ± 18.9	193.4 ± 0.3
Σ (n-3) FA	177.9	223.4	167.4	200.0	213.0	234.9
Σ (n-6) FA	23.3	15.2	18.7	21.1	11.6	11.6
Σ PUFA	201.3	238.6	186.1	221.1	224.5	246.4
mg EPA + DHA in 8 oz	370.9	470.6	354.3	426.6	454.7	513.8
oz to 1750 mg EPA + DHA	37.77	29.77	39.53	32.84	30.98	27.25

Common name	Halibut, Alaskan				
Latin name	*Hippoglossus stenolepis*				
Vendor Date Farm/Wild	GL1 Oct 2010 Wild	GL1 Aug 2012 Wild	NW1 Oct 2012 Wild	NE1 Nov 2012 Wild	NE4 May 2013 Wild
Location	Pacific Ocean, Canada	Alaska, USA	Pacific Ocean, USA	Southeast Alaska, USA	Pacific Ocean, USA
Fish 1	27 in, 12.2 lbs	27.5 in, 19.08 lbs	36 in, 10 lbs	33 in, 19.5 lbs	27.5 in, 10.5 lbs
Fish 2	29 in, 12 lbs	23.5 in, 11.4 lbs	37.5 in, 12 lbs	28 in, 17.2 lbs	27.9 in, 11.2 lbs
Fish 3	25 in, 11 lbs	23 in, 12.56 lbs	38 in, 11.5 lbs	32 in, 18.1 lbs	27.5 in, 10.7 lbs
Moisture (%)	81.36 ± 0.18	81.57 ± 0.38	82.39 ± 0.11	79.42 ± 0.21	82.86 ± 0.17
Total Fat (%)	1.39 ± 0.06	0.74 ± 0.03	0.63 ± 0.06	0.88 ± 0.03	1.21 ± 0.01
Mercury (ppb)	168.99 ± 4.12	252.88 ± 4.82	204.78 ± 16.41	258.74 ± 20.47	103.18 ± 1.89
FA (mg/100 g)					
12:0	-	-	-	-	-
14:0	22.1 ± 0.6	8.2 ± 1.3	10 ± 1.9	17.1 ± 2	20.3 ± 2
16:0	102.4 ± 3.4	65.2 ± 4.8	63.9 ± 9.5	91.6 ± 7.6	94 ± 1.2
18:0	31.1 ± 1.3	23.6 ± 1	17.9 ± 2	28.6 ± 1.3	30.1 ± 2.2
20:0	-	-	-	-	1.1 ± 0.1
22:0	-	-	-	-	-
24:0	-	-	-	-	-
Σ SFA	155.7	97.0	91.8	137.3	145.5
14:1n5	-	-	-	-	-
16:1n7	24.9 ± 0.1	11.4 ± 1.5	15.9 ± 3.7	23.6 ± 3.6	18.9 ± 2.9
18:1n7	23.6 ± 1.1	18.3 ± 1	16.8 ± 3	21 ± 2.3	19.7 ± 0.5
18:1n9	61.7 ± 2.7	41.8 ± 5.6	38.2 ± 7.8	54.5 ± 12.7	54.7 ± 1.2
20:1n9	14 ± 1.1	10.9 ± 0.5	8.9 ± 1.7	21.8 ± 7.8	32.5 ± 2.5
22:1n9	3.2 ± 0	1.7 ± 0.2	1.9 ± 0.5	3.1 ± 0.4	30.2 ± 1.3
24:1n9	4.5 ± 0.2	3.6 ± 0.5	2.8 ± 0.1	4.4 ± 0.3	5.5 ± 0.2
Σ MUFA	131.9	87.6	84.5	128.4	161.4
16:2n4	1.5 ± 0	-	-	1.5 ± 0.1	1.2 ± 0.3
16:3n4	-	-	-	-	-
LA	5.9 ± 0	6.7 ± 3.8	5.4 ± 1	4.2 ± 0.5	7.9 ± 0.5
ALA	1.9 ± 0.1	1.4 ± 0.6	-	1.2 ± 0.2	2.9 ± 0.3
18:3n4	1.1 ± 0.1	-	-	1.4 ± 0.1	1.6 ± 0.2
18:3n6	-	-	-	-	-
SDA	3.7 ± 0	2.1 ± 0.3	1.7 ± 0.4	3.5 ± 0.7	5.3 ± 1.7
20:2n6	1.4 ± 0	1.2 ± 0.3	-	1.1 ± 0.1	1.6 ± 0.2
20:3n3	-	-	-	-	-
20:3n6	-	-	-	-	-
20:4n3	2.8 ± 0.1	2.4 ± 0.2	1.9 ± 0.3	2.5 ± 0.3	4.2 ± 0
ARA	18.1 ± 1	15.7 ± 0	10 ± 1.1	13.8 ± 0.5	11.6 ± 1
EPA	76.2 ± 3.6	61.4 ± 1.4	43 ± 8	77 ± 4.7	72.7 ± 0.8
22:2n6	-	-	2.2 ± 0.4	-	-
22:4n6	1.4 ± 0.1	1.2 ± 0	-	-	-
DPAn-3	13.7 ± 0.9	13.9 ± 0.4	10.6 ± 0.7	19 ± 1	18.4 ± 0.9
DHA	144.2 ± 9.9	129.3 ± 0.7	111.6 ± 15.6	163.7 ± 5.3	192.7 ± 16.2
Σ (n-3) FA	242.4	210.6	168.9	266.8	296.1
Σ (n-6) FA	26.8	24.8	17.6	19.0	21.1
Σ PUFA	271.8	235.4	186.5	288.7	320.1
mg EPA + DHA in 8 oz	499.7	432.6	350.8	545.8	602.1
oz to 1750 mg EPA + DHA	28.07	32.37	40.38	25.68	23.30

Common name	Halibut, Alaskan				
Latin name	*Hippoglossus stenolepis*				
Vendor Date Farm/Wild	NW1 Mar 2013 Wild	SE2 Nov 2012 Wild	SE1 Apr 2013 Wild	SW1 Aug 2012 Wild	SW1 Apr 2013 Wild
Location	North Pacific Ocean, USA	USA	Alaska, USA	Alaska, USA	Pacific Ocean, USA
Fish 1	26 in, 13 lbs	37 lbs	n/a	*20+ lbs	50 in
Fish 2	27 in, 15 lbs	33 lbs	n/a	*20+ lbs	25 in, 12 lbs
Fish 3	15 in, 12.5 lbs	36 lbs	n/a	*20+ lbs	27 in, 15 lbs
Moisture (%)	83.46 ± 0.38	76.35 ± 0.44	80.89 ± 0.12	75.55 ± 0.16	76.88 ± 0.97
Total Fat (%)	0.91 ± 0.01	1.77 ± 0.2	1.14 ± 0.08	0.92 ± 0.13	6.71 ± 0.64
Mercury (ppb)	100.29 ± 7.90	130.75 ± 10.96	342.45 ± 9.27	152.46 ± 8.93	609.45 ± 55.69
FA (mg/100 g)					
12:0	-	-	-	-	4.5 ± 0.4
14:0	19.2 ± 2.9	46.7 ± 9.4	17.7 ± 0.6	10.5 ± 2.8	308.1 ± 28.7
16:0	100.2 ± 7.1	165.6 ± 22.2	96.4 ± 9	93.4 ± 13.4	774.6 ± 69.9
18:0	28.3 ± 1.9	56.8 ± 4.9	31.8 ± 3.1	35.5 ± 3.1	121.8 ± 11.6
20:0	1.1 ± 0.1	1.7 ± 0.2	1.2 ± 0.1	-	7 ± 0.4
22:0	-	-	-	-	2.3 ± 0.2
24:0	-	-	-	-	1.3 ± 0
Σ SFA	148.7	270.8	147.0	139.4	1219.5
14:1n5	-	-	-	-	8.3 ± 1
16:1n7	17.3 ± 2.1	39.1 ± 6.9	27.1 ± 1.6	27.5 ± 8.5	539.7 ± 48.3
18:1n7	13.3 ± 1.5	41.1 ± 5.4	28.8 ± 2.1	25.8 ± 5.3	240.1 ± 24.7
18:1n9	37.7 ± 3.7	172.6 ± 28.2	79.8 ± 7.6	67 ± 17.4	1499 ± 136
20:1n9	12.9 ± 1	32.2 ± 5.1	22.5 ± 1.9	9.6 ± 2.5	354.3 ± 160.4
22:1n9	1.4 ± 0.2	28.5 ± 5.4	6 ± 0.6	1.7 ± 0.6	139.6 ± 15.7
24:1n9	5.3 ± 0.4	2.8 ± 1.7	4.9 ± 0.2	1.6 ± 0.5	64.6 ± 7.2
Σ MUFA	87.9	316.3	169.0	133.2	2845.6
16:2n4	1.3 ± 0.2	8.5 ± 1.3	-	3 ± 0.7	24 ± 2.2
16:3n4	-	3.5 ± 0.5	-	-	9.3 ± 0.9
LA	8.4 ± 0.9	13.1 ± 1.9	5.8 ± 0.5	3.7 ± 0.5	79.6 ± 5.9
ALA	3.1 ± 0.4	5.5 ± 0.9	1.5 ± 0.1	-	36.1 ± 2.9
18:3n4	1.5 ± 0.1	3.7 ± 0.7	1.3 ± 0.1	1.2 ± 0.2	13.8 ± 1.5
18:3n6	-	-	-	-	6 ± 0.4
SDA	7.2 ± 0.9	11.1 ± 1.9	2.3 ± 0	1.5 ± 0.4	58.4 ± 4.5
20:2n6	1.2 ± 0.1	4.7 ± 0.7	2 ± 0.2	2.2 ± 0.5	17.2 ± 1.6
20:3n3	-	1.8 ± 0.3	1.2 ± 0.1	-	8.8 ± 0.8
20:3n6	-	1.4 ± 0.2	-	-	3.9 ± 0.3
20:4n3	4.1 ± 0.5	8.8 ± 1	3.3 ± 0.3	1.6 ± 0.3	28.1 ± 2.3
ARA	9.5 ± 0.6	18.6 ± 0.6	24.7 ± 2.4	24.2 ± 1.4	35 ± 1.9
EPA	90.5 ± 8.8	144.9 ± 11.7	95.1 ± 8.2	78.2 ± 7.4	162 ± 8.7
22:2n6	-	-	-	-	4.6 ± 0.5
22:4n6	-	1.7 ± 0.2	1.8 ± 0.2	2.6 ± 0.4	5.7 ± 0.3
DPAn-3	14 ± 0.1	30.8 ± 2.7	16.4 ± 1.6	18.8 ± 2.5	48.7 ± 2.4
DHA	156.9 ± 9.9	250.3 ± 7.1	137.2 ± 14.3	141.1 ± 5	231.4 ± 2.1
Σ (n-3) FA	275.8	453.3	256.9	241.2	573.5
Σ (n-6) FA	19.2	39.6	34.3	32.6	151.9
Σ PUFA	297.9	508.5	292.5	278.0	772.5
mg EPA + DHA in 8 oz	561.0	896.3	526.7	497.3	892.2
oz to 1750 mg EPA + DHA	25.03	15.64	26.71	28.20	15.70

Common name *Latin name*	Halibut, California *Paralichthys californicus*		Mackerel, King *Scomeromorus cavalla*	Mackerel, Spanish *Scomberomorus maculatus*	
Vendor	SW1	SW1	SE1	SE1	SE1
Date	Aug 2012	Mar 2013	Oct 2012	Oct 2012	Mar 2013
Farm/Wild	Wild	Wild	Wild	Wild	Wild
Location	California, USA	Pacific Ocean, USA	Gulf of Mexico, USA	Gulf of Mexico, USA	Gulf of Mexico, USA
Fish 1	n/a	n/a	n/a	20 in	16 in
Fish 2	n/a	n/a	n/a	15 in	16.5 in
Fish 3	n/a	n/a	n/a	16 in	15 in
Moisture (%)	77.94 ± 0.05	78.92 ± 0.10	76.48 ± 0.21	75.33 ± 0.28	77.21 ± 0.22
Total Fat (%)	0.78 ± 0.06	0.46 ± 0.01	1.34 ± 0.07	4.16 ± 0.23	3.48 ± 0.16
Mercury (ppb)	31.95 ± 0.67	88.11 ± 3.22	1424.98 ± 14.75	414.46 ± 20.28	318.15 ± 2.69
FA (mg/100 g)					
12:0	-	-	-	-	-
14:0	11.6 ± 1.5	5.6 ± 0.1	23.1 ± 1.8	74.4 ± 6.4	40.9 ± 3.1
16:0	103.8 ± 9.5	68.3 ± 0.8	299 ± 36.8	969.1 ± 59.8	746.2 ± 38.9
18:0	33.5 ± 3.4	22.9 ± 0.8	120.7 ± 16.4	309.9 ± 15.4	266.1 ± 10.7
20:0	-	-	3.9 ± 0.5	10.7 ± 0.5	14.9 ± 0.6
22:0	-	-	3.5 ± 0.5	10.5 ± 0.3	12.1 ± 0.8
24:0	-	-	3.4 ± 0.5	11.1 ± 0.3	16.5 ± 0.5
Σ SFA	148.9	96.8	453.5	1385.8	1096.6
14:1n5	-	-	-	-	-
16:1n7	16.9 ± 2	9.5 ± 0	49.5 ± 2.4	145.7 ± 9.6	114.3 ± 6.8
18:1n7	11.6 ± 1.5	6.3 ± 0.2	38 ± 1.6	109.6 ± 5.8	70 ± 4
18:1n9	44.1 ± 5.9	25.3 ± 0.1	194.4 ± 10	712.8 ± 39.1	886.8 ± 45.8
20:1n9	6.8 ± 0.7	1.6 ± 0	9.2 ± 1.6	30.5 ± 2.2	33.4 ± 3.3
22:1n9	1.3 ± 0.2	-	1.9 ± 0.3	6.5 ± 0.4	10 ± 0.6
24:1n9	-	1.5 ± 0	6.4 ± 0.4	10.2 ± 1.9	27.4 ± 0.8
Σ MUFA	80.7	44.2	299.5	1015.2	1141.9
16:2n4	1.2 ± 0.1	-	1.3 ± 0	5.4 ± 0.6	1.9 ± 0.2
16:3n4	-	-	-	5 ± 0.4	-
LA	5.1 ± 0.6	3.1 ± 0.2	12.9 ± 1.6	33.7 ± 2.2	36.1 ± 2.5
ALA	1.7 ± 0.2	-	4.9 ± 0.5	23.9 ± 0.9	5.7 ± 0.7
18:3n4	1.2 ± 0.1	-	1.9 ± 0	7.8 ± 0.6	4.7 ± 0.2
18:3n6	-	-	1.3 ± 0.2	3.7 ± 0.2	2.6 ± 0.3
SDA	2.4 ± 0.3	-	3.3 ± 0.1	16.2 ± 0.7	6.6 ± 0.5
20:2n6	1.1 ± 0.1	-	2.2 ± 0.1	5.5 ± 0	4.1 ± 0.2
20:3n3	-	-	-	3.2 ± 0.2	1.2 ± 0.1
20:3n6	-	-	2.4 ± 0.4	4.9 ± 0.3	2.2 ± 0.1
20:4n3	2 ± 0.3	-	2.7 ± 0.2	7.2 ± 0.6	2.6 ± 0.4
ARA	14.4 ± 1.1	17.2 ± 0.7	47.3 ± 7.1	78.9 ± 3.2	58.6 ± 2.7
EPA	30 ± 3.3	19.3 ± 0.6	42.2 ± 5	133.1 ± 6.4	70.6 ± 5.9
22:2n6	-	-	-	-	-
22:4n6	2.1 ± 0.1	2.5 ± 0.1	8.2 ± 1	18.8 ± 0.8	12.2 ± 1
DPAn-3	22.9 ± 2.1	17.8 ± 0.9	19.8 ± 2.5	46.6 ± 2.4	28.3 ± 1.9
DHA	182.1 ± 11	95.6 ± 4.7	185.9 ± 28.8	550 ± 20.1	371.1 ± 21.7
Σ (n-3) FA	241.1	132.7	258.9	780.1	485.9
Σ (n-6) FA	22.7	22.8	74.3	145.6	115.8
Σ PUFA	266.1	155.4	336.4	943.8	608.3
mg EPA + DHA in 8 oz	481.1	260.6	517.4	1549.3	1001.6
oz to 1750 mg EPA + DHA	29.17	53.78	27.36	9.04	14.01

Common name *Latin name*	Mahi Mahi *Coryphaena hippurus*				
Vendor Date Farm/Wild	GL1 Nov 2010 Wild	GL1 Aug 2012 Wild	NW1 Oct 2012 Wild	NE1 Nov 2012 Wild	NE3 Oct 2012 Wild
Location	Costa Rica	Panama	Pacific Ocean, Peru	Pacific Ocean, Costa Rica	Ecuador
Fish 1	41 in, 23.1 lbs	39 in, 16.4 lbs	n/a	38 in, 13.2 lbs	9 lbs
Fish 2	40 in, 22.5 lbs	37 in, 14.56 lbs	n/a	38 in, 13.8 lbs	11.5 lbs
Fish 3	42 in, 23.6 lbs	39.5 in, 16.38 lbs	n/a	35 in, 10.8 lbs	9.5 lbs
Moisture (%)	78.96 ± 0.08	79.35 ± 0.06	79.70 ± 0.11	79.07 ± 0.33	80.74 ± 0.06
Total Fat (%)	1.09 ± 0.03	0.86 ± 0.11	1.16 ± 0.10	0.60 ± 0.07	0.58 ± 0.06
Mercury (ppb)	276.74 ± 5.15	260.18 ± 9.18	172.58 ± 4.75	332.31 ± 7.99	475.85 ± 25.26
FA (mg/100 g)					
12:0	-	-	-	-	-
14:0	7.9 ± 0.3	12.6 ± 2.2	12.9 ± 3.3	4.5 ± 1.8	3.3 ± 0.1
16:0	118.3 ± 6.3	118.4 ± 16.8	162.1 ± 23.9	63.9 ± 13.3	55.8 ± 8.6
18:0	54.6 ± 2.4	54.8 ± 5.5	60.5 ± 7.5	48.2 ± 3.6	37.6 ± 3.6
20:0	-	1.3 ± 0.2	1.6 ± 0.3	-	-
22:0	-	-	1.2 ± 0.2	-	-
24:0	1.3 ± 0.1	1.2 ± 0.1	1.5 ± 0.2	-	-
Σ SFA	182.1	188.3	239.7	116.7	96.6
14:1n5	-	-	-	-	2.1 ± 0.1
16:1n7	13.4 ± 1	19.1 ± 3	24.6 ± 4.3	7 ± 2.1	4.2 ± 0.9
18:1n7	10.6 ± 0.9	14.6 ± 1.8	13.6 ± 2.1	8.1 ± 0.8	6.4 ± 1
18:1n9	87.9 ± 8	89.2 ± 10.9	119.3 ± 16.8	47.1 ± 7.2	63.6 ± 16.1
20:1n9	6.2 ± 0.9	8.6 ± 1	5.7 ± 1.2	3 ± 1	2.8 ± 0.8
22:1n9	-	1.2 ± 0.1	-	-	-
24:1n9	2.8 ± 0.1	3.7 ± 0.6	4.8 ± 0.5	-	2.5 ± 0.2
Σ MUFA	120.8	136.3	167.9	65.2	81.6
16:2n4	-	-	-	2.6 ± 0.7	2.1 ± 0.2
16:3n4	-	-	-	1.6 ± 0.3	1.5 ± 0.2
LA	4 ± 0.2	4.2 ± 0.5	5.6 ± 0.8	4.2 ± 0.4	5.2 ± 3.5
ALA	-	1.3 ± 0.2	1.3 ± 0.3	-	-
18:3n4	1.6 ± 0	1.4 ± 0.2	2.2 ± 0.2	-	-
18:3n6	-	-	-	-	-
SDA	-	1.8 ± 0.3	1.7 ± 0.6	-	-
20:2n6	1.5 ± 0.1	1.9 ± 0.2	1.9 ± 0.3	1.6 ± 0.1	-
20:3n3	-	-	-	-	-
20:3n6	-	-	-	-	-
20:4n3	1.2 ± 0.1	1.7 ± 0.2	1.6 ± 0.3	-	-
ARA	27.9 ± 0.6	23.6 ± 2.1	26.4 ± 1.5	27 ± 1.2	26.8 ± 1.1
EPA	19 ± 0.8	27.2 ± 3.2	24 ± 2.8	14.2 ± 2.7	9.7 ± 0.7
22:2n6	-	-	-	-	-
22:4n6	2.3 ± 0.2	2.2 ± 0.3	2.4 ± 0	2.1 ± 0.3	1.6 ± 0.2
DPAn-3	9.2 ± 0.6	11.8 ± 1.1	10.7 ± 1.4	7.3 ± 1.4	3.8 ± 0.5
DHA	165.9 ± 4.8	183.7 ± 13.5	192.7 ± 11.3	136.4 ± 22.5	107.2 ± 5
Σ (n-3) FA	195.3	227.5	232.1	157.9	120.7
Σ (n-6) FA	35.8	32.0	36.4	34.9	33.6
Σ PUFA	232.7	260.9	270.6	197.0	157.9
mg EPA + DHA in 8 oz	419.4	478.3	491.6	341.7	265.2
oz to 1750 mg EPA + DHA	33.41	29.37	28.54	41.57	52.86

Common name	Mahi Mahi				
Latin name	*Coryphaena hippurus*				
Vendor Date Farm/Wild	NE5 June 2013 Wild	NW1 Mar 2013 Wild	SE1 Sept 2012 Wild	SE1 Mar 2013 Wild	SW1 Aug 2012 Wild
Location	South Atlantic Ocean, Florida	South Pacific Ocean, Peru	South Atlantic Ocean, Costa Rica	Pacific Ocean, Ecuador	Costa Rica and Ecuador
Fish 1	n/a	*45 in, *12 lbs	*40 lbs	n/a	n/a
Fish 2	n/a	*48 in, *15 lbs	*40 lbs	n/a	n/a
Fish 3	n/a	*46 in, *14 lbs	*40 lbs	n/a	n/a
Moisture (%)	81.43 ± 0.28	79.05 ± 0.30	80.52 ± 0.07	80.54 ± 0.03	79.47 ± 0.31
Total Fat (%)	0.58 ± 0.03	1.04 ± 0.29	0.54 ± 0.00	0.87 ± 0.08	1.02 ± 0.14
Mercury (ppb)	237.26 ± 4.51	303.01 ± 5.94	252.39 ± 8.50	458.61 ± 28.58	188.91 ± 4.79
FA (mg/100 g)					
12:0	-	-	-	-	-
14:0	1.1 ± 0.1	12.6 ± 0	1.4 ± 0.1	1.6 ± 0.2	15.6 ± 1.1
16:0	34.9 ± 0.6	106.4 ± 2.3	40.9 ± 2.2	55.5 ± 3.9	146.5 ± 8.9
18:0	40.4 ± 0.8	45.4 ± 1.4	31.1 ± 1.3	32.8 ± 1.4	64.2 ± 4.9
20:0	-	1 ± 0.1	-	-	2.2 ± 0.1
22:0	-	-	-	-	1.4 ± 0
24:0	-	-	-	-	1.9 ± 0.3
Σ SFA	76.4	165.4	73.4	90.0	231.7
14:1n5	-	-	-	-	-
16:1n7	3.3 ± 0.2	18.1 ± 0.2	3.4 ± 0.2	4.4 ± 0.6	22 ± 1.6
18:1n7	7 ± 0	12.1 ± 0.3	5.4 ± 0.3	5.1 ± 0.3	15.1 ± 0.9
18:1n9	23.5 ± 0.4	72.9 ± 0.6	33.5 ± 1.5	37.3 ± 1.1	111.8 ± 3.7
20:1n9	1.6 ± 0.2	7.1 ± 0.7	1.1 ± 0.1	1.4 ± 0.1	10.4 ± 0.2
22:1n9	-	1.1 ± 0.1	-	-	1.9 ± 0.1
24:1n9	2.8 ± 0	3.9 ± 0.2	1.5 ± 0.2	1.7 ± 0.2	5.9 ± 1
Σ MUFA	38.2	115.3	44.8	49.9	167.0
16:2n4	-	-	1.7 ± 0.2	-	5.9 ± 0.5
16:3n4	-	-	-	-	4.5 ± 0.4
LA	2.3 ± 0.2	4.3 ± 0.1	2.8 ± 0.2	4 ± 0.4	6.6 ± 0.3
ALA	-	1.4 ± 0.1	-	-	1.4 ± 0.1
18:3n4	-	1.2 ± 0	-	-	2.5 ± 0.1
18:3n6	-	-	-	-	-
SDA	-	1.8 ± 0.1	-	-	1.4 ± 0.2
20:2n6	1.3 ± 0	1.5 ± 0	-	1 ± 0	2.4 ± 0
20:3n3	-	-	-	-	-
20:3n6	-	-	-	-	-
20:4n3	-	1.5 ± 0	-	-	2.4 ± 0.1
ARA	16 ± 1.5	20.4 ± 0.9	24 ± 1.7	27.3 ± 0.9	27.8 ± 1.6
EPA	7.9 ± 1	25.9 ± 1	8.4 ± 0.1	13.1 ± 0.5	19.5 ± 0.8
22:2n6	-	-	-	-	-
22:4n6	1.2 ± 0.1	1.3 ± 0.2	1.3 ± 0	1.3 ± 0.1	4.4 ± 0.1
DPAn-3	5.9 ± 1	9.7 ± 0	3.3 ± 0	3.4 ± 0.2	14 ± 0.2
DHA	98.2 ± 15.7	154.5 ± 1.9	84.5 ± 1.4	91.4 ± 2.3	173.3 ± 6.3
Σ (n-3) FA	111.9	194.8	96.1	107.9	211.9
Σ (n-6) FA	20.8	27.6	28.1	33.5	41.2
Σ PUFA	132.7	223.5	125.9	141.4	266.2
mg EPA + DHA in 8 oz	240.5	409.1	210.6	237.0	437.2
oz to 1750 mg EPA + DHA	58.96	34.23	66.50	59.09	32.05

Common name *Latin name*	Mahi Mahi *Coryphaena hippurus*	Monkfish *Lophius americanus*			
Vendor	SW1	GL1	GL1	NE1	NE4
Date	Apr 2013	Nov 2010	Aug 2012	Nov 2012	May 2013
Farm/Wild	Wild	Wild	Wild	Wild	Wild
Location	Pacific Ocean, Costa Rica	Atlantic Ocean	Rhode Island, USA	Gulf of Maine, USA	Gulf of Maine
Fish 1	27 in, *10+ lbs	13 in, 2.45 lbs	13 in, 1.82 lbs	13 in, 2.95 lbs	12 in, 2.25 lbs
Fish 2	27 in, *10+ lbs	12 in, 3 lbs	13.5 in, 2.8 lbs	9 in, 1.1 lbs	13 in, 2.65 lbs
Fish 3	27 in, *10+ lbs	14 in, 3.2 lbs	13.5 in, 2.28 lbs	8 in, 0.75 lbs	12.5 in, 2.75 lbs
Moisture (%)	80.79 ± 0.14	83.55 ± 0.11	83.54 ± 0.57	85.15 ± 0.08	84.02 ± 0.07
Total Fat (%)	1.04 ± 0.05	0.53 ± 0.04	0.51 ± 0.03	0.53 ± 0.00	0.52 ± 0.02
Mercury (ppb)	487.58 ± 19.57	83.60 ± 1.52	96.47 ± 3.01	71.30 ± 4.47	55.23 ± 2.56
<u>FA (mg/100 g)</u>					
12:0	-	-	-	-	-
14:0	6.6 ± 1.6	5 ± 0.6	4.3 ± 0.3	2.8 ± 0	3.3 ± 0.5
16:0	85 ± 7.4	65.4 ± 6.7	65 ± 4.1	59.5 ± 1.4	66.8 ± 9.7
18:0	52 ± 1.6	25.9 ± 4.1	20.1 ± 1.2	20.6 ± 1.4	18.6 ± 2.3
20:0	-	-	-	-	-
22:0	-	-	2 ± 0.3	-	-
24:0	1.3 ± 0	-	-	-	-
Σ SFA	144.9	96.2	91.4	83.0	88.8
14:1n5	-	-	-	-	-
16:1n7	9.8 ± 1.8	10.1 ± 1.3	10 ± 0.5	9.4 ± 0.1	7.2 ± 1
18:1n7	9.6 ± 0.6	12.8 ± 2.2	11.1 ± 1	11.3 ± 0.3	7.7 ± 1.2
18:1n9	47.8 ± 1.5	42.2 ± 6.5	40.1 ± 6.4	30.6 ± 1.7	30.9 ± 1.6
20:1n9	3.2 ± 0.2	5.3 ± 0.1	15.3 ± 0.9	4 ± 0.4	11.8 ± 1.6
22:1n9	-	-	-	-	3.2 ± 0.3
24:1n9	2.8 ± 0.2	1.2 ± 0	1.2 ± 0.1	-	1.7 ± 0
Σ MUFA	73.1	71.6	77.8	55.4	62.6
16:2n4	2.9 ± 0	-	-	-	-
16:3n4	1.7 ± 0.1	-	-	-	-
LA	4.8 ± 0.3	4.1 ± 0.9	5 ± 0.3	4.5 ± 0.4	5.9 ± 0.8
ALA	1.2 ± 0.2	-	-	-	-
18:3n4	1.2 ± 0.1	-	-	-	-
18:3n6	-	-	-	-	-
SDA	-	-	-	1.3 ± 0.1	-
20:2n6	1.7 ± 0.1	-	-	-	-
20:3n3	-	-	-	-	-
20:3n6	-	-	-	-	-
20:4n3	1.2 ± 0.1	-	-	1.1 ± 0.1	-
ARA	34.9 ± 1.6	13.7 ± 1.1	8.7 ± 0	13.7 ± 1	10.4 ± 1.4
EPA	21.6 ± 1.8	24.7 ± 1	13.5 ± 1.4	31.5 ± 1.6	22.1 ± 3
22:2n6	-	-	-	-	-
22:4n6	2.5 ± 0.2	1.6 ± 0.2	-	1.5 ± 0.1	-
DPAn-3	9.3 ± 0.1	7 ± 0.4	4.6 ± 0.2	6.7 ± 0.4	4 ± 0.5
DHA	135.5 ± 1.5	78.7 ± 4.1	80.6 ± 1.4	97.8 ± 8.6	96.5 ± 11.5
Σ (n-3) FA	168.8	110.4	98.7	138.4	122.6
Σ (n-6) FA	43.8	19.4	13.7	19.7	16.3
Σ PUFA	218.6	129.8	112.4	158.2	138.9
mg EPA + DHA in 8 oz	356.3	234.5	213.5	293.3	269.1
oz to 1750 mg EPA + DHA	39.30	59.79	65.61	47.88	52.43

Common name	Monkfish				
Latin name	*Lophius americanus*				
Vendor Date Farm/Wild	NW1 Apr 2013 Wild	SE1 Sept 2012 Wild	SE1 Apr 2013 Wild	SW1 Aug 2012 Wild	SW1 Apr 2013 Wild
Location	USA	North Atlantic Ocean, USA	North Atlantic Ocean, USA	n/a	Pacific Ocean, USA
Fish 1	15 in, 5 lbs	*<5 lbs	n/a	n/a	n/a
Fish 2	14 in, 4 lbs	*<5 lbs	n/a	n/a	n/a
Fish 3	13 in, 3 lbs	*<5 lbs	n/a	n/a	n/a
Moisture (%)	85.56 ± 0.49	84.03 ± 0.41	83.79 ± 0.09	84.78 ± 0.33	84.25 ± 0.12
Total Fat (%)	0.59 ± 0.17	0.56 ± 0.05	0.52 ± 0.03	0.48 ± 0.03	0.46 ± 0.02
Mercury (ppb)	118.22 ± 6.77	106.03 ± 8.10	84.40 ± 3.10	175.13 ± 14.49	122.78 ± 11.09
FA (mg/100 g)					
12:0	-	-	-	-	-
14:0	2.5 ± 0.1	4.9 ± 0.7	2.1 ± 0	5.7 ± 0.6	3.2 ± 0.4
16:0	51.4 ± 1.4	60.2 ± 4.9	62.9 ± 0.1	63.1 ± 7	60 ± 2.3
18:0	19.2 ± 0.5	23.1 ± 1.5	24.7 ± 0	19.9 ± 1.7	18.3 ± 1.1
20:0	-	-	-	-	-
22:0	-	-	-	2.2 ± 0	-
24:0	-	-	-	-	-
Σ SFA	73.2	88.2	89.8	90.8	81.4
14:1n5	-	-	-	-	-
16:1n7	7.3 ± 0.5	7.8 ± 0.8	7.5 ± 0.1	10.2 ± 1.4	8.2 ± 0.8
18:1n7	9.1 ± 0.5	10.9 ± 0.9	11.1 ± 0.1	11 ± 0.8	9.2 ± 0.9
18:1n9	30.5 ± 1.9	43.5 ± 2.3	40.5 ± 0.5	46.3 ± 10.5	31.1 ± 3.9
20:1n9	4.3 ± 0.2	13.5 ± 1.1	3.4 ± 0	15.7 ± 0.5	7.8 ± 0.9
22:1n9	-	-	-	-	-
24:1n9	1.1 ± 0.1	1.5 ± 0	1.6 ± 0.1	1.4 ± 0.5	1.3 ± 0.2
Σ MUFA	52.4	77.3	64.0	84.6	57.6
16:2n4	-	-	-	-	-
16:3n4	-	-	-	-	-
LA	4.3 ± 0.5	6.1 ± 0.3	3 ± 0	3.1 ± 0.4	4.7 ± 0.4
ALA	-	-	-	-	-
18:3n4	-	-	-	-	-
18:3n6	-	-	-	-	-
SDA	-	-	-	2.6 ± 0	-
20:2n6	-	-	-	-	-
20:3n3	-	-	-	-	-
20:3n6	-	-	-	-	-
20:4n3	-	-	-	-	-
ARA	11.4 ± 0.1	14.7 ± 0.4	16.6 ± 0.2	4.2 ± 0.1	12.2 ± 0.6
EPA	23.6 ± 0.4	25.5 ± 1.2	25.5 ± 0.3	4.8 ± 0.3	24.6 ± 1.4
22:2n6	-	-	-	-	-
22:4n6	1.3 ± 0.1	-	1.8 ± 0	-	1 ± 0.1
DPAn-3	5.8 ± 0.1	4.7 ± 0.1	7 ± 0	2.7 ± 0.1	-
DHA	80.9 ± 1.8	110.4 ± 4	106.1 ± 3.2	28.4 ± 0.4	92.6 ± 5.4
Σ (n-3) FA	110.2	140.7	138.7	38.4	117.2
Σ (n-6) FA	16.9	20.8	21.3	7.3	18.0
Σ PUFA	127.2	161.5	160.0	45.7	135.1
mg EPA + DHA in 8 oz	237.0	308.4	298.6	75.1	265.8
oz to 1750 mg EPA + DHA	59.10	45.44	46.90	186.44	52.77

Common name *Latin name*	Mullet, Striped *Mugil cephalus*		Pangasius/Swai *Pangasius hypophthalmus*			
Vendor Date Farm/Wild	SE1 Oct 2012 Wild	SE1 Mar 2013 Wild	GL2 Oct 2011 Farm	GL2 July 2012 Farm	NW1 Oct 2012 Farm	NE1 Dec 2012 Farm
Location	Gulf of Mexico, USA	Gulf of Mexico, USA	Vietnam	Vietnam	Vietnam	Vietnam
Fish 1	13.5 in	13.5 in	n/a	n/a	12-16 in, 2-3 lbs	n/a
Fish 2	14 in	14.5 in	n/a	n/a	12-16 in, 2-3 lbs	n/a
Fish 3	14.5 in	14 in	n/a	n/a	12-16 in, 2-3 lbs	n/a
Moisture (%)	74.46 ± 0.52	80.09 ± 0.40	86.05 ± 0.27	86.66 ± 0.06	87.36 ± 0.10	87.92 ± 0.27
Total Fat (%)	4.54 ± 0.22	0.96 ± 0.05	1.25 ± 0.18	0.93 ± 0.06	0.85 ± 0.13	0.66 ± 0.05
Mercury (ppb)	16.51 ± 1.29	10.75 ± 2.10	0.55 ± 0.19	0.47 ± 0.15	2.79 ± 0.32	3.58 ± 0.31
FA (mg/100 g)						
12:0	2.3 ± 0.4	-	8.8 ± 0.2	-	-	-
14:0	178.2 ± 20.8	5 ± 0.5	44.1 ± 1.3	28.8 ± 1.2	21 ± 3.4	18.5 ± 1.4
16:0	1168.9 ± 137	85.9 ± 1.1	335.4 ± 16.3	266.4 ± 4.4	196.9 ± 30.7	180.1 ± 9.5
18:0	130.5 ± 22.9	39.2 ± 2.2	92.5 ± 5.1	83.2 ± 0.8	59.6 ± 9.9	54.1 ± 1.1
20:0	6.5 ± 0.4	-	2.1 ± 0.1	1.4 ± 0	-	1 ± 0
22:0	3.1 ± 0.6	-	1.1 ± 0.2	-	-	-
24:0	3.4 ± 0.8	1.7 ± 0.1	1.2 ± 0.2	-	-	-
Σ SFA	1492.9	131.8	485.1	379.9	277.5	253.8
14:1n5	2.2 ± 0	-	-	-	-	-
16:1n7	364.7 ± 18.5	10.5 ± 1.2	11.3 ± 0.7	8.3 ± 0.9	6.2 ± 0.8	4.7 ± 0.3
18:1n7	64 ± 5.2	10.5 ± 0.9	8.8 ± 1	6.9 ± 0.4	6.2 ± 1	5.4 ± 0.2
18:1n9	274 ± 31.3	19.7 ± 2	402 ± 20.6	321.7 ± 1.3	234.1 ± 48.2	207.8 ± 5.2
20:1n9	14.5 ± 4	2.8 ± 0.1	14.9 ± 0.8	12.7 ± 0.3	10.1 ± 2.3	8 ± 0
22:1n9	4.5 ± 0.2	-	-	-	-	-
24:1n9	2.6 ± 1.5	1.4 ± 0.2	-	-	-	-
Σ MUFA	726.5	44.9	437.0	349.6	256.7	225.9
16:2n4	40.3 ± 0.2	1.2 ± 0.2	-	-	-	-
16:3n4	59.3 ± 3.5	4.2 ± 0.1	-	-	-	-
LA	116.3 ± 6.4	4.9 ± 1.5	95.1 ± 4.7	67.5 ± 0.6	63.9 ± 11.4	62.3 ± 1.7
ALA	36.7 ± 3.6	1 ± 0.2	4.7 ± 0.2	3.9 ± 0	3.2 ± 0.6	3 ± 0.1
18:3n4	5.8 ± 0.4	-	-	-	-	-
18:3n6	24.3 ± 0.6	1.5 ± 0	2.7 ± 0.2	3.2 ± 0	2 ± 0.3	1.9 ± 0
SDA	320.2 ± 5.4	1.6 ± 0.1	-	-	-	-
20:2n6	3.6 ± 0.4	-	7.4 ± 3.5	4.4 ± 0.1	4.7 ± 0.7	4.1 ± 0.1
20:3n3	7.6 ± 2.9	-	-	-	-	-
20:3n6	4.6 ± 0.4	1.9 ± 0.1	13.1 ± 1.5	12.4 ± 0	10.4 ± 0.7	10.3 ± 0.5
20:4n3	35.1 ± 0.3	1.9 ± 0	-	-	-	-
ARA	64.3 ± 8.3	48.4 ± 0	20.8 ± 2.8	20.1 ± 0.6	16.2 ± 0	18.6 ± 1.3
EPA	305.6 ± 23.3	42.3 ± 0.3	1.7 ± 0.3	1.4 ± 0.4	1.5 ± 0	2.1 ± 1.1
22:2n6	-	-	-	1.4 ± 0.2	-	-
22:4n6	8.8 ± 1.1	7 ± 1.2	4.7 ± 1.2	4.3 ± 0	3.3 ± 0.3	3.6 ± 0.1
DPAn-3	103.2 ± 8.3	32.4 ± 1.4	3.9 ± 0.9	3.3 ± 0.1	3.4 ± 0.3	2.8 ± 0.2
DHA	462 ± 32.7	63.4 ± 2	12.7 ± 1.8	10.4 ± 0.8	10.5 ± 0.3	12.7 ± 1
Σ (n-3) FA	1270.4	142.7	23.1	19.0	18.6	20.7
Σ (n-6) FA	221.9	63.7	143.7	113.3	100.6	100.8
Σ PUFA	1597.8	211.8	166.8	132.3	119.1	121.5
mg EPA + DHA in 8 oz	1740.8	239.7	32.7	26.9	27.2	33.7
oz to 1750 mg EPA + DHA	8.07	58.44	432.54	524.22	516.29	420.26

Common name	Pangasius/Swai				Perch, Pacific Ocean	
Latin name	*Pangasius hypophthalmus*				*Sebastes alutus*	
Vendor	NW1	SE2	SW1	SW1	NW1	NW1
Date	Mar 2013	Nov 2012	Jan 2012	Apr 2013	Oct 2012	June 2012
Farm/Wild	Farm	Farm	Farm	Farm	Wild	Wild
Location	Vietnam	Vietnam	Vietnam	Vietnam	Pacific Ocean, Canada	Pacific Ocean, Canada
Fish 1	n/a	n/a	n/a	n/a	16 in, 2.4 lbs	13.5 in, 2.5 lbs
Fish 2	n/a	n/a	n/a	n/a	17 in, 2.38 lbs	14 in, 2 lbs
Fish 3	n/a	n/a	n/a	n/a	17 in, 2.32 lbs	16 in, 2.3 lbs
Moisture (%)	87.60 ± 0.75	84.96 ± 0.42	84.59 ± 0.30	86.97 ± 0.75	77.61 ± 0.05	79.17 ± 0.36
Total Fat (%)	0.81 ± 0.09	2.06 ± 0.22	1.94 ± 0.04	1.21 ± 0.02	4.02 ± 0.22	3.24 ± 0.05
Mercury (ppb)	3.12 ± 0.39	1.68 ± 0.18	2.40 ± 0.53	2.84 ± 0.52	78.58 ± 4.52	281.8 ± 14.64
FA (mg/100 g)						
12:0	-	-	8.4 ± 0.5	-	1.2 ± 0.2	-
14:0	22.6 ± 5.4	70.3 ± 7.8	43.6 ± 1.3	43.4 ± 2.1	128.2 ± 18.7	51.2 ± 0.2
16:0	193.8 ± 26.7	603.3 ± 82.9	356.1 ± 19.7	350.5 ± 16.6	671.2 ± 76.5	282.6 ± 7.1
18:0	56.4 ± 7	186.1 ± 26.1	106.7 ± 8.1	109.6 ± 6.7	110.2 ± 10.5	57.3 ± 2.2
20:0	-	3.8 ± 0.6	2.5 ± 0.3	2.1 ± 0.1	3.3 ± 0.4	2.6 ± 0.1
22:0	-	1.7 ± 0.2	1.4 ± 0.1	1.1 ± 0	2.1 ± 0.4	1.7 ± 0.1
24:0	-	1.9 ± 0.4	1.3 ± 0.1	1.1 ± 0	1.4 ± 0	1.1 ± 0
Σ SFA	272.8	867.2	519.9	507.7	917.7	396.4
14:1n5	-	-	-	-	2.7 ± 0.3	2.2 ± 0
16:1n7	7.6 ± 3	19.2 ± 2.4	11.2 ± 0.9	13 ± 0	229.5 ± 30.3	109.5 ± 2.9
18:1n7	6.7 ± 1.5	14.9 ± 1.5	10 ± 0.4	10.1 ± 0.2	186.9 ± 20.6	79.4 ± 2.8
18:1n9	216.1 ± 29	797.3 ± 122.8	437.8 ± 33.6	409.3 ± 21.7	501.5 ± 58.6	366.4 ± 13.8
20:1n9	9.5 ± 2.1	27.8 ± 4.1	14.8 ± 1.6	14.4 ± 0.8	39.1 ± 3.8	126.1 ± 5.6
22:1n9	-	-	-	-	14.3 ± 1.4	24.3 ± 1.3
24:1n9	-	-	-	-	11.3 ± 2.3	27.8 ± 1.4
Σ MUFA	240.0	859.2	473.6	446.7	985.2	735.8
16:2n4	-	-	-	-	24.5 ± 3.2	4.4 ± 0.1
16:3n4	-	1.3 ± 0.2	-	-	21.5 ± 2.8	8.2 ± 0.2
LA	58.2 ± 6.8	197.8 ± 25.1	119.6 ± 6.5	100.4 ± 4.5	40.5 ± 4.7	28.3 ± 0.6
ALA	2.9 ± 0.4	10.6 ± 1.4	5.3 ± 0.4	6.6 ± 0.3	21.5 ± 2.5	8.8 ± 0.3
18:3n4	-	-	-	-	4.7 ± 0.5	2.3 ± 0.2
18:3n6	1.9 ± 0.2	5.8 ± 0.9	3.5 ± 0.4	1.4 ± 0	4.4 ± 0.5	1.3 ± 0
SDA	-	-	-	-	75.1 ± 8.4	13.8 ± 0.4
20:2n6	4 ± 0.4	10.4 ± 1.3	6.6 ± 0.2	6.9 ± 0.3	5.8 ± 0.5	3.5 ± 0.1
20:3n3	-	-	-	-	3.7 ± 0.2	2.1 ± 0.1
20:3n6	10.4 ± 0.7	20.2 ± 2	16.3 ± 0	10.5 ± 0.3	2.4 ± 0.2	1.5 ± 0.1
20:4n3	-	-	-	-	15.2 ± 1.6	6.3 ± 0.1
ARA	16.8 ± 1	25.8 ± 2.7	28.1 ± 1.6	15.4 ± 0.2	32.1 ± 3.5	18.8 ± 0.7
EPA	1.2 ± 0.1	2.7 ± 0.3	2.4 ± 0.2	3.8 ± 0.3	454.1 ± 44.5	90.1 ± 3.5
22:2n6	-	2.4 ± 0.4	-	-	-	-
22:4n6	3.4 ± 0.3	5.7 ± 0.7	5.7 ± 0.1	2.9 ± 0	3.4 ± 0.3	1.1 ± 0
DPAn-3	2.9 ± 0.2	4.8 ± 0.4	4.9 ± 0.1	4.9 ± 0.2	33.8 ± 2.6	9.1 ± 0.2
DHA	11.1 ± 0.6	17 ± 1.4	21.7 ± 0.5	25.3 ± 0.1	371.4 ± 21.6	171.8 ± 4.5
Σ (n-3) FA	18.1	35.1	34.4	40.7	974.9	302.0
Σ (n-6) FA	94.8	268.1	179.8	137.5	88.6	54.4
Σ PUFA	112.9	304.6	214.1	178.2	1114.2	371.3
mg EPA + DHA in 8 oz	27.9	44.8	54.8	66.1	1872.3	593.8
oz to 1750 mg EPA + DHA	504.17	314.14	255.92	211.80	7.51	23.59

Common name	Perch, White		Perch, Yellow		Pollock, Alaskan	
Latin name	*Morone americana*		*Perca flavescens*		*Theragra chalcogramma*	
Vendor Date Farm/Wild	MA1 Apr 2013 Wild	MA2 July 2013 Wild	GL1 Oct 2010 Wild	GL1 Aug 2012 Wild	GL2 Oct 2011 Wild	GL2 July 2012 Wild
Location	USA	Chesapeake Bay, USA	Lake Erie, Canada	Canada	China	n/a
Fish 1	9.25 in, 0.6 lbs	7 in, 0.4 lbs	n/a	n/a	n/a	n/a
Fish 2	9 in, 0.64 lbs	8 in, 0.6 lbs	n/a	n/a	n/a	n/a
Fish 3	9.75 in, 0.72 lbs	7 in, 0.4 lbs	n/a	n/a	n/a	n/a
Moisture (%)	76.08 ± 0.20	76.63 ± 0.58	81.56 ± 0.09	79.81 ± 0.36	84.90 ± 0.14	85.60 ± 0.64
Total Fat (%)	6.53 ± 0.41	5.02 ± 0.05	0.71 ± 0.05	1.23 ± 0.07	0.65 ± 0.04	11.92 ± 0.99
Mercury (ppb)	101.02 ± 4.45	194.41 ± 2.96	36.90 ± 2.89	31.53 ± 2.16	13.78 ± 0.63	21.01 ± 0.41
FA (mg/100 g)						
12:0	3.1 ± 0.2	2.4 ± 0.4	-	-	-	-
14:0	123 ± 11.5	127.6 ± 11.9	6.6 ± 0.4	12.1 ± 0.9	9 ± 0.8	5.3 ± 0.3
16:0	926.9 ± 44.4	999.6 ± 57.4	103.1 ± 12.5	123.4 ± 2	100.6 ± 2.2	87.7 ± 2.7
18:0	128.4 ± 2.2	146.4 ± 0.7	32.4 ± 4.1	35.6 ± 1	20.4 ± 0.5	17.1 ± 0.4
20:0	5.3 ± 0.4	5.7 ± 0.2	-	-	-	-
22:0	2.6 ± 0	2.5 ± 0	-	-	-	-
24:0	2 ± 0	2.4 ± 0.2	-	-	-	-
Σ SFA	1191.4	1286.4	142.0	171.2	130.0	110.2
14:1n5	12 ± 0.4	11.1 ± 1.2	-	-	-	-
16:1n7	732.2 ± 100.7	659.6 ± 31.7	29.9 ± 3.6	53.9 ± 4.1	8.4 ± 0.3	8.3 ± 0.3
18:1n7	263 ± 5.1	255.3 ± 11.1	24.1 ± 3	26.6 ± 0.6	16.5 ± 1.2	18 ± 0.2
18:1n9	1147.1 ± 66.6	1149.5 ± 67.5	34.5 ± 4.2	44.8 ± 0.8	29.6 ± 3	31 ± 0.3
20:1n9	44.6 ± 2.4	45.6 ± 0	1.1 ± 0.1	1.3 ± 0.2	6.1 ± 0.7	8.8 ± 0
22:1n9	5.1 ± 0.5	5.9 ± 0.8	-	-	1 ± 0	-
24:1n9	7 ± 0.9	7.4 ± 0.2	1.4 ± 0.1	1.6 ± 0.3	2.4 ± 0.5	2.5 ± 0.3
Σ MUFA	2211.0	2134.3	90.9	128.3	64.1	68.6
16:2n4	26.5 ± 3	25.9 ± 1.6	1.4 ± 0.2	3.1 ± 0.3	-	-
16:3n4	9.9 ± 1.4	9.8 ± 0.7	-	1.9 ± 0.1	-	-
LA	157.2 ± 22.7	174.7 ± 19.1	18.2 ± 2.3	17.3 ± 0.6	3.8 ± 0.3	3.6 ± 0.1
ALA	153.4 ± 22.3	157.7 ± 4.8	4.4 ± 0.6	6.2 ± 0.2	1.5 ± 0.1	1.1 ± 0
18:3n4	11.6 ± 1.3	10.8 ± 0.5	-	1.1 ± 0	-	-
18:3n6	10.4 ± 0.7	11.3 ± 0.7	-	-	-	-
SDA	33.1 ± 5.1	39.8 ± 1.7	2 ± 0.2	2.8 ± 0.1	2.7 ± 0.2	2.7 ± 0
20:2n6	22.4 ± 0.3	23.5 ± 1.3	-	-	-	-
20:3n3	14.3 ± 0.3	14.8 ± 0.2	-	-	-	-
20:3n6	12.3 ± 0.6	10.9 ± 0	-	-	-	-
20:4n3	41.9 ± 4.2	40.9 ± 1.4	1.3 ± 0.2	1.8 ± 0.1	2 ± 0.2	2.1 ± 0
ARA	213.1 ± 1.6	221.9 ± 7.3	31.6 ± 4.1	37.1 ± 0.1	6.3 ± 0.5	7.8 ± 0.1
EPA	348.5 ± 12.1	340.7 ± 14.2	47.1 ± 5.6	57.5 ± 0.1	84.6 ± 6.6	92.3 ± 1.3
22:2n6	1.2 ± 0.2	2.1 ± 0.7	-	-	-	-
22:4n6	25.6 ± 0.6	28.8 ± 0.7	3 ± 0.4	6.6 ± 0.4	-	-
DPAn-3	113 ± 3.4	125.8 ± 6.7	13.1 ± 1.6	15.5 ± 0.3	11.9 ± 0	9 ± 0.1
DHA	307.2 ± 16.6	319.6 ± 17.8	93.6 ± 10.8	104.6 ± 2.2	171 ± 21.6	150.3 ± 0.8
Σ (n-3) FA	1011.3	1039.3	161.5	188.3	273.6	257.5
Σ (n-6) FA	442.2	473.3	52.7	61.0	10.1	11.4
Σ PUFA	1501.5	1559.1	215.6	255.5	283.7	268.8
mg EPA + DHA in 8 oz	1487.1	1497.6	319.1	367.6	579.7	550.2
oz to 1750 mg EPA + DHA	9.43	9.35	44.18	38.10	24.30	25.45

Common name *Latin name*	Pollock, Alaskan *Theragra chalcogramma*					Pollock, Atlantic *Pollachius pollachius*
Vendor Date Farm/Wild	NW1 Oct 2012 Wild	NW1 Apr 2013 Wild	SE2 Nov 2012 Wild	SW1 Oct 2011 Wild	SW1 Apr 2013 Wild	NE2 May 2013 Wild
Location	Pacific Ocean, Alaska	Gulf of Alaska	USA	North Pacific Ocean, USA	Pacific Ocean, USA	Gulf of Maine, USA
Fish 1	n/a	13 in, 2.2 lbs	n/a	n/a	n/a	n/a
Fish 2	n/a	8 in, 1.8 lbs	n/a	n/a	n/a	n/a
Fish 3	n/a	9 in, 2 lbs	n/a	n/a	n/a	n/a
Moisture (%)	88.73 ± 0.37	89.18 ± 0.35	83.10 ± 0.18	81.42 ± 0.38	82.19 ± 0.18	81.51 ± 0.14
Total Fat (%)	0.62 ± 0.02	0.82 ± 0.02	0.77 ± 0.13	10.80 ± 0.96	0.79 ± 0.10	0.80 ± 0.01
Mercury (ppb)	6.18 ± 0.47	3.25 ± 0.44	18.59 ± 2.25	5.95 ± 0.44	9.08 ± 1.22	193.24 ± 6.44
FA (mg/100 g)						
12:0	-	-	-	-	-	-
14:0	4 ± 0.4	6.6 ± 0.2	4.7 ± 1.1	4.3 ± 0.6	3 ± 0.1	3.6 ± 0.2
16:0	71.2 ± 8	75.8 ± 2.7	123.8 ± 5.3	125.8 ± 8.2	103.8 ± 6.9	85.6 ± 4.9
18:0	12.1 ± 1.2	11.8 ± 0.4	27.3 ± 1.1	25.8 ± 1.6	25 ± 1.6	26.7 ± 0.7
20:0	-	-	-	-	-	-
22:0	-	-	-	-	-	-
24:0	-	-	-	-	-	-
Σ SFA	87.3	94.1	155.9	156.0	131.9	115.9
14:1n5	-	-	-	-	-	-
16:1n7	6 ± 1	7.1 ± 0.2	7.2 ± 1.6	5.9 ± 0.7	4.4 ± 0.3	3.6 ± 0.1
18:1n7	15.5 ± 1.7	13.6 ± 0.5	31.1 ± 0.9	29.1 ± 1.4	25.4 ± 1.2	10.8 ± 0.1
18:1n9	22.9 ± 3.9	21 ± 0.7	58.4 ± 11.9	44.4 ± 3.6	41.6 ± 1.8	39 ± 0.5
20:1n9	3.2 ± 0.4	5.6 ± 0.3	6.1 ± 0.5	2 ± 0.3	2.5 ± 0	7.1 ± 0.4
22:1n9	-	-	-	-	-	1.5 ± 0.2
24:1n9	1.9 ± 0.6	2 ± 0.1	-	2.8 ± 0.6	2.8 ± 0.4	3.3 ± 0.2
Σ MUFA	49.6	49.3	102.9	84.2	76.6	65.3
16:2n4	-	-	-	-	-	-
16:3n4	-	-	-	-	-	-
LA	2.4 ± 0.2	2.4 ± 0.2	9.6 ± 6.4	3.6 ± 0.2	3 ± 0.1	4.1 ± 0
ALA	-	-	2 ± 1.3	-	-	1.1 ± 0
18:3n4	-	-	-	-	-	-
18:3n6	-	-	-	-	-	-
SDA	1.4 ± 0.1	2.1 ± 0.1	2.3 ± 0.4	2.3 ± 0.3	2.3 ± 0.1	1.1 ± 0
20:2n6	-	-	-	-	-	-
20:3n3	-	-	-	-	-	-
20:3n6	-	-	-	-	-	-
20:4n3	1.3 ± 0.1	1.5 ± 0.1	2.1 ± 0.4	1.8 ± 0.1	1.5 ± 0.1	1.5 ± 0
ARA	4.2 ± 0.4	4 ± 0.2	8 ± 0.7	10.3 ± 0.7	6.9 ± 0.4	11.1 ± 0.3
EPA	60.1 ± 4.5	73.6 ± 4	99.4 ± 10	118.5 ± 6.7	90.5 ± 6.4	50.3 ± 1.5
22:2n6	-	-	-	-	-	-
22:4n6	-	-	-	-	-	-
DPAn-3	6.3 ± 0.5	6.1 ± 0.4	7.3 ± 1.3	5.6 ± 0.4	5.9 ± 0	6.6 ± 0.1
DHA	117.8 ± 7.4	108.1 ± 6.2	151 ± 14.3	176.1 ± 8.8	164.2 ± 8.5	195 ± 0.5
Σ (n-3) FA	186.8	191.3	264.2	304.4	264.4	255.6
Σ (n-6) FA	6.6	6.3	17.6	13.8	9.9	15.2
Σ PUFA	193.4	197.7	281.8	318.3	274.3	270.8
mg EPA + DHA in 8 oz	403.4	412.1	568.0	668.2	577.7	556.4
oz to 1750 mg EPA + DHA	34.79	34.03	24.77	20.98	24.28	25.17

Common name	Pollock, Atlantic			Pompano, Florida	
Latin name	*Pollachius pollachius*			*Trachinotus ovatus*	
Vendor Date Farm/Wild	NE1 Nov 2012 Wild	NE2 Nov 2012 Wild	NE4 May 2013 Wild	SE3 Oct 2012 Wild	SE1 Aug 2013 Wild
Location	Gulf of Maine, USA	Gulf of Maine, USA	Gulf of Maine	Gulf of Mexico, Mexico	Gulf of Mexico, USA
Fish 1	28 in, 9.75 lbs	*36 in, *5 lbs	n/a	11.5 in, 1.55 lbs	11 in
Fish 2	27.5 in, 8.5 lbs	*40 in, *10 lbs	n/a	11.5 in, 1.55 lbs	9 in
Fish 3	27 in, 8.2 lbs	*30 in, *3 lbs	n/a		10.5 in
Moisture (%)	80.06 ± 0.09	80.19 ± 0.09	80.55 ± 0.04	67.77 ± 0.46	71.07 ± 0.21
Total Fat (%)	1.26 ± 0.09	1.14 ± 0.06	1.21 ± 0.03	20.03 ± 1.87	9.76 ± 0.05
Mercury (ppb)	173.50 ± 15.06	187.93 ± 3.54	161.32 ± 9.34	72.24 ± 3.13	59.49 ± 3.88
FA (mg/100 g)					
12:0	-	-	-	3.9 ± 0	4.4 ± 0
14:0	11.3 ± 1.3	4.1 ± 0.1	4.7 ± 0.3	441.6 ± 8.7	238.6 ± 0.1
16:0	150.9 ± 8.4	109.6 ± 1.7	124.6 ± 2.3	3605.3 ± 73.6	2623.7 ± 10.3
18:0	46.5 ± 2.1	34.1 ± 0.9	44 ± 0.4	1259.2 ± 1.5	864.1 ± 14.7
20:0	-	-	-	50.6 ± 0.3	34.4 ± 0.2
22:0	-	-	-	39.3 ± 0.5	25.6 ± 0.3
24:0	-	-	-	12.6 ± 0.4	7.9 ± 0
Σ SFA	208.7	147.8	173.3	5412.5	3798.7
14:1n5	-	-	-	3.1 ± 0.2	1.8 ± 0
16:1n7	15.7 ± 1.5	5.2 ± 0.3	7.8 ± 0.1	658 ± 11.1	571.9 ± 0.7
18:1n7	33.3 ± 1.6	18.1 ± 1.1	26.3 ± 0.1	293.1 ± 0.9	224.7 ± 5.2
18:1n9	109.5 ± 8.5	65.2 ± 6	83.3 ± 2.4	3038.7 ± 10.1	1994 ± 48.8
20:1n9	44.2 ± 6.1	10.8 ± 1.2	15.6 ± 0.2	235.3 ± 6.7	139.1 ± 1.4
22:1n9	1.7 ± 0.2	-	5.3 ± 0.1	72.8 ± 1.7	46.7 ± 0
24:1n9	5.4 ± 0.5	2.2 ± 0.6	4.7 ± 0.5	36.9 ± 0.6	26.7 ± 0
Σ MUFA	209.9	101.5	142.9	4338.0	3004.7
16:2n4	-	-	-	15.2 ± 0.4	12.5 ± 0
16:3n4	-	-	-	6.6 ± 0.5	10.5 ± 0
LA	13.5 ± 0.7	4.9 ± 0.1	7 ± 0.1	47.1 ± 1.6	39.4 ± 0.4
ALA	4.6 ± 0.2	1.6 ± 0.1	2.1 ± 0	21.5 ± 0.6	39.1 ± 0.3
18:3n4	-	-	-	24 ± 0.5	17.6 ± 0.1
18:3n6	-	-	-	9.4 ± 0.1	9.9 ± 0.1
SDA	4.7 ± 0.4	1.8 ± 0.1	1.3 ± 0	20.5 ± 0.2	31.9 ± 0.7
20:2n6	2.4 ± 0.2	1.3 ± 0.1	1.9 ± 0	74.1 ± 0.8	47.1 ± 0.1
20:3n3	1.8 ± 0.1	-	1.2 ± 0	7.1 ± 0.1	11.7 ± 0.1
20:3n6	-	-	-	27.2 ± 0	18.4 ± 0.1
20:4n3	4.1 ± 0.3	2.1 ± 0.1	2.7 ± 0	35.4 ± 0.5	33.1 ± 0.8
ARA	18.1 ± 1	14.9 ± 0.2	18.7 ± 0.5	169 ± 3.6	149.2 ± 0.1
EPA	92.1 ± 5.6	72.5 ± 0.8	62.9 ± 1.4	121 ± 1.1	165.4 ± 0.6
22:2n6	-	-	-	8.3 ± 0.1	4.7 ± 0.1
22:4n6	-	-	-	139.8 ± 3.2	70.4 ± 0.2
DPAn-3	13.1 ± 1.3	5.2 ± 0.3	10.7 ± 0.1	237.9 ± 3.2	181.9 ± 0.9
DHA	342.7 ± 22.6	224.4 ± 7.9	319.7 ± 4.1	500.7 ± 10.5	448.5 ± 2.3
Σ (n-3) FA	463.1	307.5	400.6	944.1	911.6
Σ (n-6) FA	34.0	21.0	27.6	474.9	339.1
Σ PUFA	497.1	328.6	428.2	1464.8	1291.3
mg EPA + DHA in 8 oz	986.2	673.4	867.7	1410.0	1392.2
oz to 1750 mg EPA + DHA	14.23	20.80	16.14	9.93	10.06

Common name	Rockfish, Brown		Rockfish, Widow		Roughy, Orange
Latin name	*Sebastes entomelas*		*Sebastes auriculatus*		*Hoplostethus atlanticus*
Vendor	NW1	NW1	NW1	NW1	GL2
Date	Oct 2012	Mar 2013	Sept 2012	Mar 2013	Oct 2011
Farm/Wild	Wild	Wild	Wild	Wild	Wild
Location	Pacific Ocean, USA	Pacific Ocean, USA	Pacific Ocean, Canada	Pacific Ocean, Canada	New Zealand
Fish 1	n/a	*12 in, *1.35 lbs	n/a	*10 in, *1 lb	n/a
Fish 2	n/a	*11 in, *1.45 lbs	n/a	*11 in, *1.25 lbs	n/a
Fish 3	n/a	*13 in, *1.5 lbs	n/a	*11 in, *1.13 lbs	n/a
Moisture (%)	80.46 ± 0.17	79.23 ± 0.97	78.76 ± 0.72	80.33 ± 0.11	77.66 ± 0.63
Total Fat (%)	1.74 ± 0.24	1.68 ± 0.08	1.85 ± 0.03	1.18 ± 0.05	6.75 ± 0.30
Mercury (ppb)	214.40 ± 17.55	537.85 ± 45.65	117.85 ± 4.26	55.92 ± 3.01	342.94 ± 6.44
FA (mg/100 g)					
12:0	-	2.4 ± 0.6	3 ± 0.5	-	-
14:0	36.1 ± 4.4	53.9 ± 10.4	79.3 ± 13.4	12.5 ± 3	21.7 ± 4
16:0	214.4 ± 26.4	207.8 ± 8	287.3 ± 19.7	147.4 ± 3.1	60.9 ± 6.9
18:0	52.4 ± 6.4	52.3 ± 1	61 ± 0.5	41.1 ± 0.7	24.4 ± 1.2
20:0	1.3 ± 0.2	2.3 ± 0.2	1.9 ± 0.2	-	10.9 ± 1.2
22:0	-	1.2 ± 0	-	-	-
24:0	-	-	-	-	4 ± 0.6
Σ SFA	304.3	319.8	432.4	201.0	121.9
14:1n5	-	-	-	-	6.1 ± 0.8
16:1n7	49.7 ± 7.3	60.8 ± 2.8	76.7 ± 12.4	20.7 ± 5	232.9 ± 22.3
18:1n7	42.8 ± 6.5	34.7 ± 2.5	59.1 ± 7.5	29 ± 4	100.3 ± 11.4
18:1n9	137.6 ± 21.8	188.6 ± 18.4	213.5 ± 24.5	67.6 ± 14.2	1102.8 ± 105.2
20:1n9	24.8 ± 2.8	94.9 ± 15	37 ± 5.3	7.7 ± 1.5	471.3 ± 60.7
22:1n9	15.5 ± 0.7	63.9 ± 12.6	2.8 ± 0.6	2.2 ± 0.6	34.8 ± 5.2
24:1n9	6.2 ± 0.7	12.4 ± 0.8	2.4 ± 0.5	4.5 ± 0.7	13.6 ± 2.2
Σ MUFA	276.6	455.3	391.5	131.7	1961.8
16:2n4	3.3 ± 0.4	4 ± 0.7	6.2 ± 0.9	2.1 ± 0.5	14.9 ± 1.4
16:3n4	2 ± 0.2	2.8 ± 0.6	4 ± 0.7	1.5 ± 0.5	20.3 ± 2.2
LA	16.1 ± 2.3	11.2 ± 0	17.5 ± 1.4	9.6 ± 0.5	44.7 ± 5.7
ALA	7.3 ± 1	4.3 ± 0.2	9 ± 1.8	2.4 ± 0.4	21.7 ± 12.8
18:3n4	1.3 ± 0.2	2.4 ± 0.2	3.2 ± 0.4	-	12.8 ± 2
18:3n6	-	-	1.4 ± 0.1	-	24.8 ± 2.6
SDA	12.5 ± 2.1	6.2 ± 0.8	17.9 ± 3.6	4.6 ± 1.1	13.4 ± 2.5
20:2n6	2.5 ± 0.3	2.9 ± 0.1	3.3 ± 0.3	1.2 ± 0.2	129.7 ± 19.8
20:3n3	1.6 ± 0.2	1.7 ± 0.1	1.6 ± 0.4	-	2.8 ± 0.4
20:3n6	1.1 ± 0.1	-	1.1 ± 0	-	354.7 ± 37.2
20:4n3	5.7 ± 0.7	4.8 ± 0.5	6.5 ± 0.6	2.2 ± 0.3	15.9 ± 1.9
ARA	17.6 ± 1.5	24.2 ± 0	15.6 ± 0.3	11.2 ± 0.2	21.3 ± 1.8
EPA	117.1 ± 11.6	96.4 ± 11	153.9 ± 7.6	66.1 ± 4.8	39 ± 3.9
22:2n6	-	-	-	-	-
22:4n6	1.9 ± 0.1	2.5 ± 0.1	2 ± 1	-	10.8 ± 0.1
DPAn-3	22.8 ± 2.4	23.3 ± 2.8	20.5 ± 0.4	11.4 ± 0.9	6.9 ± 0.7
DHA	276.4 ± 17.7	211 ± 18.6	224.2 ± 16.2	232.1 ± 0.9	99.3 ± 8.1
Σ (n-3) FA	443.6	347.7	433.6	318.9	199.0
Σ (n-6) FA	39.2	40.7	40.8	22.1	586.0
Σ PUFA	489.4	397.6	487.8	344.5	833.1
mg EPA + DHA in 8 oz	892.6	697.2	857.4	676.5	313.8
oz to 1750 mg EPA + DHA	15.73	20.18	16.33	20.70	44.79

Common name *Latin name*	Roughy, Orange *Hoplostethus atlanticus*				Salmon, Atlantic *Salmo salar*
Vendor Date Farm/Wild	GL2 July 2012 Wild	NW1 Oct 2012 Wild	NE5 July 2013 Wild	NW1 Mar 2013 Wild	GL1 Nov 2010 Farm
Location	n/a	South Pacific Ocean, Australia	New Zealand	Tasman Sea, Australia	Faroe Islands
Fish 1	n/a	n/a	n/a	*19 in, *3.5 lbs	24 in, 4.91 lbs
Fish 2	n/a	n/a	n/a	*18 in, *3.8 lbs	23 in, 4.78 lbs
Fish 3	n/a	n/a	n/a	*18 in, *4 lbs	23 in, 4.78 lbs
Moisture (%)	77.94 ± 0.10	76.10 ± 0.82	76.01 ± 1.54	77.01 ± 0.39	59.34 ± 0.20
Total Fat (%)	6.91 ± 0.03	6.77 ± 0.66	6.96 ± 0.27	6.62 ± 0.00	16.75 ± 0.14
Mercury (ppb)	733.87 ± 28.12	761.02 ± 70.90	584.89 ± 27.91	874.89 ± 51.36	41.51 ± 0.88
FA (mg/100 g)					
12:0	-	-	-	-	10.2 ± 0.3
14:0	17.6 ± 1.8	27 ± 0.3	30.2 ± 1.1	32.3 ± 2.3	1000.3 ± 15.5
16:0	52.5 ± 3.2	90.2 ± 2.9	102.4 ± 2.9	88.1 ± 6.4	2179.1 ± 43.7
18:0	13.9 ± 1.3	28.2 ± 1	36.4 ± 1	27.3 ± 0.4	396.3 ± 9.5
20:0	-	-	-	1.4 ± 0.3	21.3 ± 0.8
22:0	-	-	-	-	5.6 ± 0.1
24:0	-	-	4.5 ± 0.5	-	-
Σ SFA	84.0	145.4	173.5	149.1	3612.7
14:1n5	4.7 ± 0.5	7.8 ± 0.1	8.4 ± 0.4	9 ± 0.6	35.3 ± 0.7
16:1n7	206.5 ± 16.8	338.6 ± 10.3	353.7 ± 15.4	340.8 ± 11.6	936.5 ± 15.7
18:1n7	178.5 ± 108.9	172.4 ± 8.7	176.9 ± 7.5	215.5 ± 2	362.6 ± 2.3
18:1n9	1017.3 ± 40.6	1498.5 ± 54	2053.8 ± 93.5	1884.8 ± 10.8	2226 ± 50.6
20:1n9	211.6 ± 2.2	425.6 ± 8.8	567 ± 31.7	498.2 ± 19.2	1364.9 ± 29
22:1n9	28.7 ± 4.5	41.2 ± 0.4	78.7 ± 14.3	66.5 ± 7.6	-
24:1n9	-	-	24.2 ± 1.4	23.8 ± 1.7	10.8 ± 0.7
Σ MUFA	1647.2	2484.0	3262.7	3038.5	4936.2
16:2n4	7.8 ± 8.4	2.7 ± 0.1	4.6 ± 0.1	15.7 ± 0.7	78.3 ± 0.8
16:3n4	-	-	-	48.4 ± 2.1	43.3 ± 1.3
LA	27.5 ± 2.4	35.3 ± 1.7	59.6 ± 10.9	41.1 ± 0.5	469.7 ± 9.7
ALA	8.2 ± 5.6	7.7 ± 1.1	11.2 ± 1.2	7.4 ± 2.4	196.5 ± 4
18:3n4	14.8 ± 6.1	5.6 ± 0.4	8.4 ± 0.3	5.2 ± 0.1	49.6 ± 1.3
18:3n6	-	2.7 ± 2.4	2.2 ± 0.1	1.3 ± 0.1	19.1 ± 0.2
SDA	3.3 ± 0.5	-	7.4 ± 0.6	4.1 ± 0.6	374.3 ± 7.1
20:2n6	7.7 ± 0.4	23.1 ± 2.5	9 ± 0.3	12 ± 1.8	60.7 ± 2.6
20:3n3	9.9 ± 8.2	-	24.5 ± 3.9	8.6 ± 5.3	34.8 ± 0.7
20:3n6	-	2.4 ± 0.4	-	3.1 ± 0.6	26.4 ± 0.6
20:4n3	7.3 ± 0.7	9.6 ± 1.5	34.8 ± 16.7	11.7 ± 5.4	325.4 ± 6
ARA	16.1 ± 2.6	28.7 ± 1.3	53.4 ± 3.8	24.4 ± 4.4	83.8 ± 2.2
EPA	20.9 ± 1.5	31.3 ± 0.7	69.1 ± 24.1	38.2 ± 6.4	1141.5 ± 23.6
22:2n6	-	-	-	-	6.5 ± 0.3
22:4n6	-	-	-	13.8 ± 5.5	28.9 ± 0.6
DPAn-3	6.6 ± 1.6	3.9 ± 5.5	-	16.6 ± 4.3	485.1 ± 10.6
DHA	72.4 ± 4.2	111.3 ± 7.7	156.8 ± 5.7	119.6 ± 5	2028.9 ± 37.8
Σ (n-3) FA	128.5	163.8	303.9	206.2	4586.5
Σ (n-6) FA	51.3	92.2	124.3	95.7	695.0
Σ PUFA	202.5	264.2	441.1	371.2	5452.6
mg EPA + DHA in 8 oz	211.6	323.5	512.3	357.9	7190.3
oz to 1750 mg EPA + DHA	66.29	43.33	27.42	39.23	1.95

Common name *Latin name*	Salmon, Atlantic *Salmo salar*				
Vendor Date Farm/Wild	GL1 Aug 2012 Farm	NW1 Sept 2012 Farm	NE1 Nov 2012 Farm	NE4 May 2013 Farm	NW1 Mar 2013 Farm
Location	Canada	Chile	New Brunswick, Canada	Faroe Islands	Pacific Ocean, Canada
Fish 1	28 in, 11.88 lbs	22 in, 7 lbs	27.5 in, 8.6 lbs	31 in, 11.65 lbs	*22-24 in, *6-8 lbs
Fish 2	29 in, 11.06 lbs	21 in, 6.7 lbs	27 in, 9.3 lbs	n/a	*22-24 in, *6-8 lbs
Fish 3	28.25 in, 12.12 lbs	23 in, 7.4 lbs	27 in, 8.2 lbs	n/a	*22-24 in, *6-8 lbs
Moisture (%)	66.20 ± 0.10	61.59 ± 0.17	72.10 ± 0.07	71.30 ± 0.62	67.01 ± 0.82
Total Fat (%)	13.33 ± 0.76	15.62 ± 0.37	20.00 ± 1.03	10.70 ± 0.40	9.33 ± 0.41
Mercury (ppb)	23.44 ± 0.55	1.58 ± 0.05	4.46 ± 0.21	32.75 ± 1.32	5.76 ± 1.16
FA (mg/100 g)					
12:0	8.2 ± 0.1	14.6 ± 0.2	12.7 ± 0.3	3.7 ± 0.2	8 ± 0.3
14:0	770.3 ± 16.2	279.5 ± 3.8	446 ± 16.6	394.7 ± 17.9	203.7 ± 7.2
16:0	1721.1 ± 38.1	1690.1 ± 26.7	2166.3 ± 90.4	1066.1 ± 49.4	1151.1 ± 30.4
18:0	321.8 ± 8.9	520 ± 4.2	652.9 ± 93.1	217.9 ± 9.8	369.2 ± 10.2
20:0	19 ± 1	19.3 ± 0.4	42.3 ± 1.6	16.1 ± 0.4	16.5 ± 0.7
22:0	4.8 ± 1.6	11.4 ± 0.7	24 ± 1.2	7.5 ± 0.1	8.3 ± 0
24:0	4.4 ± 0.1	4.2 ± 0.1	10.1 ± 0.5	3.4 ± 0.2	5.4 ± 2.9
Σ SFA	2849.6	2539.1	3354.4	1709.3	1762.3
14:1n5	7.1 ± 0.1	3 ± 0.5	3.7 ± 0.1	3.1 ± 0.1	1.9 ± 0
16:1n7	865.1 ± 35.5	415.6 ± 8.6	593.2 ± 25.4	435 ± 19.9	301.3 ± 7.9
18:1n7	370.6 ± 11.2	291 ± 0.7	445.3 ± 57.7	246.3 ± 11.5	231.4 ± 10.2
18:1n9	1713.6 ± 91.2	2876.6 ± 7.3	5079.4 ± 730.9	1850.4 ± 67.8	2461.9 ± 66.6
20:1n9	961.2 ± 74.1	166.2 ± 3.8	264.9 ± 12.3	441.4 ± 9.4	138.9 ± 2.9
22:1n9	103.2 ± 9.9	19.1 ± 1.4	31.6 ± 1.7	386.3 ± 12.2	17.9 ± 0.8
24:1n9	69.2 ± 32.8	15.9 ± 6.1	21.1 ± 0	38.5 ± 1.6	15.9 ± 1.6
Σ MUFA	4089.9	3787.3	6439.1	3401.0	3169.3
16:2n4	65.9 ± 1.4	39 ± 0.1	57.4 ± 1.3	35.6 ± 1.6	27.3 ± 0.8
16:3n4	42.4 ± 0.6	33.8 ± 0.7	50.7 ± 1.5	24.4 ± 0.8	22.8 ± 0.9
LA	384.3 ± 19.2	2789 ± 81.6	2746.1 ± 107.8	530.3 ± 18	1827.1 ± 64.6
ALA	128.2 ± 6.8	323.4 ± 4.1	561 ± 21.8	213.4 ± 6.6	240.5 ± 9.2
18:3n4	46.1 ± 0.2	28.9 ± 1.8	44.7 ± 1.8	26 ± 1.1	18.8 ± 1.2
18:3n6	13.3 ± 0.1	36.7 ± 1.8	27.8 ± 0.8	19.9 ± 0.7	16.2 ± 0.4
SDA	205.8 ± 10.2	72.8 ± 0.4	102.8 ± 3.2	107.2 ± 4	44.1 ± 0.5
20:2n6	49.1 ± 2.4	183.9 ± 2.7	172.1 ± 6	49.1 ± 1.7	116.6 ± 4.3
20:3n3	22 ± 1	26.5 ± 0.8	39 ± 1.3	23.8 ± 0.6	18.6 ± 0.7
20:3n6	23.8 ± 1.6	71.6 ± 0.4	56.3 ± 1.3	17 ± 0.5	40 ± 1.8
20:4n3	204.7 ± 9.7	70.2 ± 1.1	107.5 ± 3.2	118.6 ± 4.3	49 ± 1.6
ARA	72.8 ± 3.4	57.4 ± 0.5	64.7 ± 2.1	47.4 ± 1	42.5 ± 1.8
EPA	922.5 ± 42.4	433.3 ± 3.8	661.5 ± 18.4	520.1 ± 22	279.4 ± 8.3
22:2n6	4.7 ± 0.3	16.8 ± 0.2	16.7 ± 1.1	4.3 ± 0.2	11.4 ± 0.2
22:4n6	29.1 ± 0.5	15 ± 2	19.6 ± 0.8	14.6 ± 0.1	13 ± 0.4
DPAn-3	420.6 ± 22.5	224.2 ± 2.3	334.7 ± 11.8	258.3 ± 9.1	176.6 ± 8.4
DHA	1251.9 ± 24.1	438.8 ± 13.3	725.5 ± 35.8	874.9 ± 32.2	328.8 ± 15.9
Σ (n-3) FA	3155.8	1589.2	2531.9	2116.3	1136.9
Σ (n-6) FA	577.2	3170.4	3103.3	682.5	2066.9
Σ PUFA	3887.5	4861.3	5788.0	2884.8	3272.7
mg EPA + DHA in 8 oz	4931.6	1977.9	3145.6	3163.8	1379.3
oz to 1750 mg EPA + DHA	2.84	7.08	4.46	4.43	10.16

Common name	Salmon, Atlantic				
Latin name	*Salmo salar*				
Vendor	SE1	SE1	SW1	SW1	NE3
Date	Sept 2012	Apr 2013	Aug 2012	Apr 2013	Oct 2012
Farm/Wild	Farm	Farm	Farm	Farm	Farm
Location	Chile	Chile	Atlantic Ocean, Canada	Atlantic Ocean, Canada	Chile
Fish 1	n/a	n/a	9.4 lbs	17.2 in, 2.5 lbs	12 lbs
Fish 2	n/a	n/a	10.4 lbs	17 in, 2.4 lbs	12 lbs
Fish 3	n/a	n/a	35 in, 13.1 lbs	16.8 in, 2.3 lbs	12 lbs
Moisture (%)	59.57 ± 0.53	59.64 ± 0.11	64.67 ± 0.75	66.32 ± 1.16	64.26 ± 0.24
Total Fat (%)	22.72 ± 0.68	19.50 ± 0.58	18.19 ± 0.34	15.71 ± 1.50	19.32 ± 0.61
Mercury (ppb)	3.26 ± 0.29	10.23 ± 0.55	6.55 ± 0.13	6.47 ± 2.06	4.03 ± 0.20
FA (mg/100 g)					
12:0	26.8 ± 1.8	27.6 ± 0.3	8 ± 0	18.2 ± 1.6	12.2 ± 0.3
14:0	693 ± 43.1	514 ± 6	363.4 ± 15.9	283.9 ± 23.3	425.7 ± 12.6
16:0	2879.3 ± 161.5	2446.3 ± 17.2	1978.9 ± 99	1499.5 ± 118.6	2063.7 ± 70.3
18:0	875.9 ± 44.7	875.5 ± 75.2	543.3 ± 26	492.6 ± 19.7	594.5 ± 100.7
20:0	47.3 ± 2.4	51.4 ± 0.1	29.1 ± 1.9	30.7 ± 2.6	40.1 ± 1
22:0	28.8 ± 0.6	32 ± 1.7	13.2 ± 1	20 ± 1.4	22.6 ± 0.6
24:0	12.3 ± 0.8	14.7 ± 0.3	6.4 ± 0.1	8.7 ± 0.6	9.3 ± 0.1
Σ SFA	4563.4	3961.5	2942.3	2353.5	3168.1
14:1n5	4.9 ± 0.1	3.8 ± 0.2	7.6 ± 0.1	3.2 ± 1.5	3.6 ± 0.1
16:1n7	903 ± 54.5	664.9 ± 10.4	663.9 ± 30.5	353.7 ± 25.4	570.8 ± 12
18:1n7	593.7 ± 32.2	588.6 ± 57.6	456 ± 12.9	315.3 ± 10.4	456.9 ± 21.3
18:1n9	5039.9 ± 264.9	6267.3 ± 588.3	5323.4 ± 183.3	3512.9 ± 111.8	5046.7 ± 163.8
20:1n9	318.2 ± 18.6	317.6 ± 8.1	217.3 ± 11.8	174.7 ± 14.1	253.9 ± 1.7
22:1n9	42.9 ± 2.7	43.2 ± 1	25.3 ± 1.4	22.7 ± 1.3	29.9 ± 0.8
24:1n9	36.2 ± 15.9	39.2 ± 0.3	20.7 ± 13	23.8 ± 2.6	19.2 ± 2.3
Σ MUFA	6938.8	7924.6	6714.1	4406.3	6381.0
16:2n4	96.3 ± 5.7	69.3 ± 1.8	44 ± 1.7	34.5 ± 2.4	54.9 ± 1.1
16:3n4	81.7 ± 4.6	58.5 ± 0.5	37.1 ± 1.6	28.9 ± 2.6	47.8 ± 1.7
LA	4082.3 ± 235.6	4685.8 ± 401	1722.1 ± 77.9	2416.5 ± 181	2623.8 ± 29
ALA	616.9 ± 38.6	715.2 ± 6.8	469 ± 25.2	469.4 ± 37.3	537.4 ± 3.1
18:3n4	75 ± 1.9	49.7 ± 1.7	29 ± 1.2	26 ± 1.7	42.3 ± 0.6
18:3n6	53.9 ± 14.8	42.8 ± 0.7	22.5 ± 1.2	23.3 ± 1.1	27.4 ± 0.8
SDA	162.9 ± 8.7	131.5 ± 1.2	75.1 ± 2.6	66.8 ± 4.5	98.8 ± 0.7
20:2n6	265.9 ± 14.7	268.3 ± 5.6	100.2 ± 5.1	152.9 ± 13.3	163.9 ± 1.7
20:3n3	49.4 ± 3.9	51.6 ± 1.4	28.8 ± 1.7	36 ± 3.4	37.4 ± 0.3
20:3n6	89.3 ± 5.8	97.9 ± 0.5	48.3 ± 2.2	47.9 ± 3.5	53.5 ± 0.6
20:4n3	167.8 ± 7.8	134.5 ± 2.9	84.2 ± 2.7	74.7 ± 6.7	102.6 ± 0.5
ARA	94.8 ± 7.6	73.8 ± 0.7	82.7 ± 3.3	42.8 ± 3.4	63.1 ± 0.5
EPA	1043.7 ± 61.4	745.2 ± 10.8	552 ± 24.7	365.9 ± 31.5	643.3 ± 3.3
22:2n6	25.7 ± 1.2	26.3 ± 0	11 ± 1	14.1 ± 1.4	15.2 ± 0.1
22:4n6	28.8 ± 2	21.9 ± 0.5	22.2 ± 2	9.3 ± 0.1	17.4 ± 0.8
DPAn-3	572 ± 34.4	421.8 ± 5.1	248.1 ± 14.3	194.6 ± 17.6	323.6 ± 1.9
DHA	1100.7 ± 45.5	803.5 ± 12.7	524.3 ± 10.6	512.9 ± 41.7	707.6 ± 0.3
Σ (n-3) FA	3713.4	3003.2	1981.5	1720.3	2450.6
Σ (n-6) FA	4640.7	5216.8	2009.0	2706.9	2964.2
Σ PUFA	8607.1	8397.4	4100.6	4516.5	5559.8
mg EPA + DHA in 8 oz	4863.4	3512.2	2441.0	1993.1	3063.7
oz to 1750 mg EPA + DHA	2.88	3.99	5.74	7.05	4.57

Common name	Salmon, Chinook				
Latin name	*Oncorhynchus tshawytscha*				
Vendor Date Farm/Wild	NE5 June 2013 Farm	SW1 Apr 2013 Farm	GL1 Oct 2010 Wild	GL1 Aug 2012 Wild	NW1 Sept 2012 Wild
Location	n/a	USA	Columbia River, Washington, USA	California, USA	Columbia River/ Pacific Ocean, USA
Fish 1	n/a	21 in, 5 lbs	23 in, 8.6 lbs	24 in, 7.74 lbs	28 in, 12.3 lbs
Fish 2	n/a	22 in, 5.3 lbs	20 in, 8.9 lbs	23.75 in, 7.84 lbs	25 in, 11.7 lbs
Fish 3	n/a	23 in, 5.4 lbs	24 in, 8.7 lbs	24 in, 8.98 lbs	27 in, 12.6 lbs
Moisture (%)	67.64 ± 0.70	63.48 ± 0.39	70.50 ± 0.26	73.32 ± 0.15	71.88 ± 0.52
Total Fat (%)	11.74 ± 0.84	16.61 ± 0.37	9.16 ± 0.08	4.76 ± 0.07	6.34 ± 0.43
Mercury (ppb)	84.21 ± 3.07	117.81 ± 5.32	61.12 ± 1.31	38.50 ± 0.44	46.20 ± 1.57
FA (mg/100 g)					
12:0	6.8 ± 0.4	11.2 ± 0	4 ± 0.2	4.4 ± 0.5	4.6 ± 0.1
14:0	385.3 ± 24	507.5 ± 7.8	481.7 ± 32.2	162.7 ± 15	178 ± 5.4
16:0	2185.7 ± 145.5	3011.3 ± 54.8	1218.3 ± 66.7	1138 ± 102.6	1224 ± 47.6
18:0	523.6 ± 42.4	762.8 ± 14	244.5 ± 11.8	277.6 ± 21.8	345.2 ± 12.7
20:0	15.9 ± 1.3	20.6 ± 0.7	13.7 ± 0.9	5.5 ± 1.2	6.3 ± 0.1
22:0	7.5 ± 0.4	11.1 ± 0	3.3 ± 0.3	2.7 ± 0.2	2.5 ± 0.1
24:0	5.9 ± 0.4	5.7 ± 0.1	2.1 ± 0	1.1 ± 0	2.1 ± 0.2
Σ SFA	3130.7	4330.2	1967.6	1592.0	1762.7
14:1n5	5.1 ± 0.9	13.4 ± 0.4	6.8 ± 0.2	3.4 ± 0.5	3.2 ± 0
16:1n7	797.2 ± 54	1234.8 ± 36.3	547 ± 31.5	374.3 ± 34.6	444.2 ± 15.6
18:1n7	446.5 ± 37.7	560.9 ± 4.2	202.3 ± 11.1	210.8 ± 16.9	265.5 ± 7.5
18:1n9	4497 ± 334.9	5110.2 ± 194.6	1613.1 ± 84.4	1376 ± 106.9	1906.2 ± 72
20:1n9	298.4 ± 18.1	225.6 ± 6.1	185.7 ± 14.9	61.7 ± 4.1	112.6 ± 2.5
22:1n9	46.2 ± 2.8	28.9 ± 1.3	34.5 ± 0.2	11.1 ± 0.6	15.7 ± 1.3
24:1n9	59.6 ± 5	40.9 ± 0.9	64.3 ± 4.9	4.6 ± 0.5	24.3 ± 4.7
Σ MUFA	6150.1	7214.8	2653.8	2041.9	2771.7
16:2n4	48.2 ± 3.3	82.1 ± 1	36 ± 0.8	32.4 ± 3	31.1 ± 1.1
16:3n4	24.9 ± 1.3	43.3 ± 1.7	16.1 ± 0.4	12.2 ± 1.1	8.6 ± 0.9
LA	1256.6 ± 81.5	670.1 ± 74.4	110 ± 5.7	36.7 ± 3	49.5 ± 1.8
ALA	169 ± 11.4	139.9 ± 11.3	77.1 ± 5.2	22.9 ± 1.8	30.5 ± 1.2
18:3n4	31.9 ± 3	36 ± 1.1	24 ± 1.4	11.8 ± 0.9	11.1 ± 1.5
18:3n6	19.3 ± 1.3	17 ± 1.4	7 ± 0.7	1.9 ± 0.2	1.7 ± 0
SDA	113.4 ± 7.4	110.5 ± 3.1	188.2 ± 12.9	35.3 ± 2.9	31.5 ± 1
20:2n6	84 ± 6.4	27.9 ± 1.5	14.1 ± 0.7	6.7 ± 0.5	9.2 ± 0.3
20:3n3	17.7 ± 1	10.4 ± 0.6	7.1 ± 0.4	4 ± 0.3	5.8 ± 0.1
20:3n6	59 ± 3.7	25.1 ± 0.9	7.8 ± 0.3	3.3 ± 0.2	4.9 ± 0
20:4n3	98.3 ± 6.2	87.8 ± 1.1	138.5 ± 8.9	33.3 ± 2.4	39 ± 1.8
ARA	77.6 ± 5	71.6 ± 1.3	38 ± 1.6	29.2 ± 2.1	35.3 ± 1.6
EPA	528.5 ± 32.8	944.8 ± 6.5	493.4 ± 21.7	498.8 ± 36.2	474.9 ± 24.9
22:2n6	8.4 ± 0.6	3.6 ± 0.1	1.5 ± 0.2	-	1.3 ± 0.1
22:4n6	13.7 ± 0.6	12.1 ± 0.9	7.2 ± 0.1	6.9 ± 0.6	6.4 ± 3
DPAn-3	194.7 ± 9.4	349.7 ± 2.3	191.7 ± 5.8	157.5 ± 10.4	248.2 ± 12.8
DHA	684.1 ± 11.3	908.3 ± 15.4	858.5 ± 30.9	493.7 ± 34	504 ± 38.8
Σ (n-3) FA	1805.7	2551.2	1954.5	1245.6	1333.9
Σ (n-6) FA	1518.6	827.3	185.5	84.8	108.3
Σ PUFA	3429.3	3540.0	2216.1	1386.7	1493.0
mg EPA + DHA in 8 oz	2750.2	4202.6	3066.1	2251.1	2220.0
oz to 1750 mg EPA + DHA	5.09	3.33	4.57	6.24	6.32

Common name *Latin name*	Salmon, Chinook *Oncorhynchus tshawytscha*		Salmon, Coho *Oncorhynchus kisutch*		
Vendor Date Farm/Wild	NW1 Mar 2013 Wild	SW1 Aug 2012 Wild	GL1 Oct 2010 Wild	GL1 Aug 2012 Wild	NW1 Sept 2012 Wild
Location	Pacific Ocean, USA	Southeast Alaska, USA	Pacific Ocean, Alaska	Pacific Ocean	Pacific Ocean, Alaska
Fish 1	31 in, 10 lbs	n/a	18 in, 6.5 lbs	23.5 in, 6.36 lbs	24 in, 8 lbs
Fish 2	33 in, 12 lbs	n/a	18 in, 6.4 lbs	24.25 in, 6.9 lbs	23 in, 7.7 lbs
Fish 3	32 in, 11.5 lbs	n/a	17 in, 6.35 lbs	23.5 in, 6.84 lbs	25 in, 8.3 lbs
Moisture (%)	73.24 ± 0.69	72.05 ± 0.16	76.05 ± 0.41	73.24 ± 0.23	75.80 ± 0.17
Total Fat (%)	6.85 ± 0.45	8.91 ± 0.34	3.53 ± 0.30	3.97 ± 0.07	2.62 ± 0.14
Mercury (ppb)	48.43 ± 4.82	40.35 ± 2.61	42.53 ± 2.06	25.03 ± 0.32	41.48 ± 2.20
FA (mg/100 g)					
12:0	6.4 ± 0.6	4.9 ± 0.2	-	1.1 ± 0.2	1.1 ± 0
14:0	332.2 ± 13.7	482.9 ± 45.4	117.8 ± 14.3	148.1 ± 11.9	29.2 ± 39.5
16:0	1217.2 ± 37	1544.5 ± 133.1	322.1 ± 23.4	503.8 ± 37.9	396.5 ± 2.1
18:0	271.9 ± 6.6	315.2 ± 28.9	71.6 ± 5.2	87.1 ± 6.8	99.2 ± 0.7
20:0	10 ± 0	14.9 ± 1.2	3.1 ± 0.5	3.4 ± 0.2	1.3 ± 0
22:0	3.9 ± 0.1	5.6 ± 1	1 ± 0	1.4 ± 0.3	1.1 ± 0
24:0	2.7 ± 0	3.9 ± 0.4	-	-	-
Σ SFA	1844.4	2371.9	515.7	744.9	528.4
14:1n5	3.9 ± 0	5.2 ± 0.5	2 ± 0.3	1.7 ± 0.2	-
16:1n7	481.8 ± 15.6	674.4 ± 65.4	107.2 ± 13.3	118.2 ± 8.7	124.8 ± 2.7
18:1n7	211.1 ± 5.6	282.3 ± 21.1	45.1 ± 4.6	49.5 ± 3.7	89.5 ± 1.9
18:1n9	1468.7 ± 47.3	2061.1 ± 208.7	337.5 ± 43	337.2 ± 24.4	390.6 ± 11.3
20:1n9	150.3 ± 1.7	291.1 ± 44.8	54.8 ± 3.6	307.1 ± 19	29.7 ± 0.8
22:1n9	24.8 ± 0.2	25.7 ± 22.4	12 ± 1.6	16 ± 1.1	5.3 ± 0
24:1n9	42.4 ± 0.1	54.7 ± 14	21.3 ± 2.2	17.8 ± 19.9	7.1 ± 1.1
Σ MUFA	2382.9	3394.6	579.9	847.4	647.0
16:2n4	43.5 ± 1.8	51.2 ± 4.9	4.2 ± 0.6	9.5 ± 4.1	10 ± 2.1
16:3n4	21.7 ± 0.9	24.2 ± 1.4	1.5 ± 0.3	5.4 ± 4.1	4.8 ± 0.2
LA	67.6 ± 1.4	117.6 ± 13	36.4 ± 4.1	39.3 ± 1.9	20.4 ± 0.3
ALA	45.9 ± 0.8	82 ± 9.5	28.2 ± 2.4	28.6 ± 1.3	11 ± 0
18:3n4	21.8 ± 0.4	24.1 ± 0.1	6.6 ± 0.8	7.7 ± 1.8	4 ± 0.2
18:3n6	4.4 ± 0.4	6.9 ± 0.9	2.3 ± 0	3.5 ± 0.4	1.3 ± 0
SDA	98.6 ± 2.3	148.2 ± 18.5	41.1 ± 4.1	52 ± 1.9	17.4 ± 0.3
20:2n6	10.3 ± 0.2	13.9 ± 1.5	9 ± 1	15.1 ± 1	3.5 ± 0.1
20:3n3	5.6 ± 0.1	8.4 ± 1.4	4.2 ± 0.4	8.8 ± 0.3	1.8 ± 0
20:3n6	6.8 ± 0.2	8.1 ± 1	3 ± 0.3	4.2 ± 0.1	2.5 ± 0
20:4n3	76.4 ± 1.4	99.9 ± 11.4	32.3 ± 2.8	35.1 ± 0.8	15.4 ± 0.3
ARA	31.9 ± 0.8	38 ± 3.6	14.9 ± 0.8	19.4 ± 0.4	17.1 ± 0.1
EPA	548.3 ± 22.7	462.3 ± 54.5	137.2 ± 6.2	230.8 ± 3.7	233.9 ± 3.2
22:2n6	1.3 ± 0.1	-	-	1.4 ± 0.6	-
22:4n6	5.5 ± 0	6.3 ± 4.3	2.8 ± 0.3	3.2 ± 0.6	3 ± 0.2
DPAn-3	213.6 ± 5.3	108.8 ± 12.8	80.8 ± 6.1	57.5 ± 0.9	121 ± 1.1
DHA	586.8 ± 3.8	606.1 ± 47.4	454.2 ± 7.8	556.4 ± 26.1	327.2 ± 1.9
Σ (n-3) FA	1575.2	1515.7	777.9	969.3	727.7
Σ (n-6) FA	127.9	190.8	68.4	86.1	47.9
Σ PUFA	1790.0	1806.0	858.6	1077.9	794.5
mg EPA + DHA in 8 oz	2574.5	2423.1	1341.3	1785.5	1272.6
oz to 1750 mg EPA + DHA	5.44	5.81	10.45	7.85	11.00

Common name	Salmon, Coho				Salmon, Sockeye
Latin name	*Oncorhynchus kisutch*				*Oncorhynchus nerka*
Vendor	NE1	NW1	SE1	SW1	GL1
Date	Dec 2012	Mar 2013	Sept 2012	Apr 2013	Aug 2011
Farm/Wild	Wild	Wild	Wild	Wild	Wild
Location	Pacific Ocean, USA	Gulf of Alaska, USA	USA	Pacific Ocean, USA	Gulf of Alaska
Fish 1	n/a	*22-26 in, *4-6 lbs	6 lbs	n/a	n/a
Fish 2	n/a	*22-26 in, *4-6 lbs	6 lbs	n/a	n/a
Fish 3	n/a	*22-26 in, *4-6 lbs	6 lbs	n/a	n/a
Moisture (%)	76.13 ± 0.51	72.95 ± 0.28	75.31 ± 0.44	72.89 ± 1.03	76.12 ± 0.26
Total Fat (%)	1.86 ± 0.14	3.80 ± 0.15	2.26 ± 0.06	6.34 ± 0.17	2.29 ± 0.11
Mercury (ppb)	40.65 ± 0.61	31.73 ± 1.68	16.39 ± 0.37	30.70 ± 1.16	40.09 ± 1.65
FA (mg/100 g)					
12:0	-	1.1 ± 0.1	-	2 ± 0.1	-
14:0	65.8 ± 12.4	198.2 ± 10.4	43.7 ± 3.9	231.8 ± 22.3	45.1 ± 3.9
16:0	259.4 ± 42.6	561.3 ± 20.2	374.1 ± 30	866.1 ± 62.1	260.8 ± 23.6
18:0	57.1 ± 9.4	97.6 ± 1.5	94.3 ± 7.5	146.8 ± 7.9	47.2 ± 4.3
20:0	1.6 ± 0.4	4.2 ± 0.1	1.7 ± 0.3	5.9 ± 0.6	1.2 ± 0.1
22:0	-	1.8 ± 0.2	-	2.2 ± 0	-
24:0	-	1.1 ± 0	-	-	-
Σ SFA	383.9	865.5	513.8	1254.8	354.4
14:1n5	-	3 ± 0.2	-	3.7 ± 0.3	-
16:1n7	66.4 ± 12.8	166.2 ± 6.6	113.6 ± 9.1	194.9 ± 16.2	48.8 ± 5.2
18:1n7	35.5 ± 5.3	84.7 ± 3.2	78.5 ± 6.2	87.1 ± 5.9	35.4 ± 3.8
18:1n9	210.2 ± 44.8	424.7 ± 4.7	347.4 ± 26.6	658.5 ± 40.5	166.7 ± 19.5
20:1n9	29.7 ± 6	86.7 ± 1	20.5 ± 1.6	465.4 ± 30.1	38.5 ± 2.1
22:1n9	7.1 ± 1.5	18.6 ± 0.1	3.5 ± 0.4	30.7 ± 2.7	6.4 ± 0.6
24:1n9	10.9 ± 4.8	29.8 ± 0.2	6.5 ± 1.8	42.6 ± 5.1	11.8 ± 0.2
Σ MUFA	359.7	813.7	569.9	1482.8	307.6
16:2n4	4.3 ± 0.7	12 ± 0.5	8.8 ± 0.8	6.7 ± 0.6	4 ± 0.4
16:3n4	2.2 ± 0.1	5.9 ± 0.4	5 ± 0.2	15.4 ± 1.8	2.3 ± 0.3
LA	15.2 ± 2.3	40.7 ± 1	14.8 ± 1	56 ± 4.9	13.9 ± 1.7
ALA	12.8 ± 1.4	38 ± 1.5	9.5 ± 0.7	37.8 ± 3.4	9.4 ± 0.8
18:3n4	3.3 ± 0.2	6.7 ± 0.1	3.2 ± 0.1	6.4 ± 0.4	2.9 ± 0.2
18:3n6	-	3.7 ± 0.2	-	5.2 ± 0	1.1 ± 0.2
SDA	21.2 ± 2.3	94.4 ± 4.9	16.9 ± 1.3	72.2 ± 4.9	17.4 ± 2
20:2n6	5.4 ± 0.9	9.5 ± 0.2	2.7 ± 0.1	22 ± 1.7	6 ± 0.6
20:3n3	3.5 ± 0.6	5.8 ± 0	1.5 ± 0.1	14.4 ± 1	3.5 ± 0.5
20:3n6	1.2 ± 0.1	3.2 ± 0	1.4 ± 0.1	4.4 ± 0.3	-
20:4n3	16.3 ± 1.2	41.7 ± 1	11.7 ± 0.6	50.2 ± 3.5	10.4 ± 1.3
ARA	9 ± 1	16.6 ± 0.1	15.3 ± 0.9	23.7 ± 0.6	9 ± 1.1
EPA	121.4 ± 9.8	284.5 ± 6.9	212.6 ± 12.1	367.5 ± 11.8	114.6 ± 13.2
22:2n6	-	-	-	1.6 ± 0.3	-
22:4n6	-	2.5 ± 0.3	1.8 ± 0.7	3 ± 0.7	-
DPAn-3	40.4 ± 3.9	76.5 ± 2.5	67.1 ± 4.7	77.2 ± 3	29.1 ± 3.2
DHA	367 ± 16.5	549.4 ± 0	300.8 ± 12.9	872.5 ± 0.8	378.4 ± 34
Σ (n-3) FA	582.5	1090.3	620.1	1491.7	562.9
Σ (n-6) FA	30.8	76.1	35.9	115.9	29.9
Σ PUFA	623.1	1191.0	673.0	1636.0	602.0
mg EPA + DHA in 8 oz	1107.5	1891.4	1164.5	2812.3	1118.1
oz to 1750 mg EPA + DHA	12.66	7.41	12.04	4.98	12.58

Common name	Salmon, Sockeye				
Latin name	*Oncorhynchus nerka*				
Vendor Date Farm/Wild	GL1 Aug 2012 Wild	NW1 Aug 2012 Wild	NW1 Mar 2013 Wild	SW1 Aug 2012 Wild	SW1 Apr 2013 Wild
Location	Alaska, USA	Pacific Ocean, Canada	Gulf of Alaska, USA	USA	Pacific Ocean, USA
Fish 1	15 in, 2.78 lbs	n/a	*20-26 in, *4-6 lbs	12 in, 3.5 lbs	17 in, 2.3 lbs
Fish 2	14 in, 2.62 lbs	n/a	*20-26 in, *4-6 lbs	19 in, 4.25 lbs	18.2 in, 2.4 lbs
Fish 3	15.5 in, 3.86 lbs	n/a	*20-26 in, *4-6 lbs	19 in, 3.2 lbs	17.5 in, 2.3 lbs
Moisture (%)	73.08 ± 0.29	76.33 ± 0.56	71.16 ± 0.02	72.78 ± 0.17	71.68 ± 0.51
Total Fat (%)	4.44 ± 0.54	3.56 ± 0.02	7.24 ± 0.11	5.61 ± 0.36	6.08 ± 0.59
Mercury (ppb)	35.19 ± 0.76	45.65 ± 4.52	27.90 ± 0.64	31.89 ± 1.95	30.45 ± 1.91
<u>FA (mg/100 g)</u>					
12:0	1.3 ± 0.1	-	2 ± 0	2 ± 0.1	1.6 ± 0.2
14:0	123.2 ± 5.6	96.5 ± 0.9	229 ± 2.5	169.9 ± 6	188.7 ± 24.8
16:0	514.8 ± 25.6	438.6 ± 0.3	809 ± 10.2	725.2 ± 32.9	792.1 ± 76.6
18:0	93.6 ± 4	85.5 ± 0.7	116.7 ± 0.7	116.7 ± 4.8	116.1 ± 6.6
20:0	3.9 ± 0.2	3.9 ± 0	6.1 ± 0	4.6 ± 0.1	5.3 ± 0.6
22:0	1.4 ± 0	1.7 ± 0.1	-	1.3 ± 0	2 ± 0
24:0	-	-	-	-	1.3 ± 0
Σ SFA	738.2	626.1	1162.9	1019.7	1107.1
14:1n5	1.9 ± 0.2	1.8 ± 0	4.1 ± 0.1	2.7 ± 0.1	3.7 ± 0.5
16:1n7	119.8 ± 7.2	120.7 ± 1.5	320 ± 2.2	200.2 ± 9.2	221.6 ± 28.9
18:1n7	90.3 ± 5.2	106.2 ± 0.8	180.3 ± 1.8	158.7 ± 7.8	177.6 ± 19.4
18:1n9	462.4 ± 28.4	569.3 ± 12.1	854.1 ± 5.7	658.2 ± 32	832.5 ± 103.9
20:1n9	199.7 ± 136.1	127.1 ± 0	247.6 ± 10.5	138.8 ± 7.9	172.3 ± 18.6
22:1n9	35.7 ± 2.2	47 ± 0.8	80.3 ± 0.3	47.2 ± 3	53.5 ± 6.1
24:1n9	23 ± 0.8	36 ± 3.1	66.5 ± 1.3	3.7 ± 0.3	45.7 ± 4.1
Σ MUFA	932.8	1008.1	1752.9	1209.7	1506.9
16:2n4	4.9 ± 0.3	4.8 ± 0.3	14.1 ± 0.1	19.2 ± 0.7	10.4 ± 1.3
16:3n4	1.6 ± 0.3	1.7 ± 0.1	3.4 ± 0.2	13.7 ± 0.5	2.7 ± 0.4
LA	45.8 ± 2.5	52.3 ± 0.4	71.7 ± 0.1	68.2 ± 3	84.1 ± 10.6
ALA	28.5 ± 1.8	24.8 ± 0.3	32.3 ± 0.1	40.3 ± 1.6	45 ± 4.7
18:3n4	3.4 ± 0.1	3.6 ± 0	8 ± 0	8.5 ± 0.4	6 ± 0.4
18:3n6	2.4 ± 0.1	2 ± 0	3.6 ± 0.4	3.7 ± 0.2	3.6 ± 0.5
SDA	38.8 ± 2.5	36.9 ± 1.1	53.3 ± 0	61.8 ± 2.8	67.5 ± 8
20:2n6	10.9 ± 0.5	9.6 ± 0	17.6 ± 0.1	15.6 ± 0.9	15.5 ± 1.8
20:3n3	5.5 ± 0.2	3.7 ± 0.1	7.2 ± 0.1	7.6 ± 0.5	7.4 ± 1.1
20:3n6	3.7 ± 0.2	3.6 ± 0	5.5 ± 0	5.7 ± 0.2	4.9 ± 0.4
20:4n3	35.8 ± 2.1	30.5 ± 0.6	45.6 ± 0.3	51.3 ± 2.1	46.9 ± 4
ARA	16.2 ± 0.8	18.5 ± 0.4	19.9 ± 0.3	22.1 ± 0.6	23.4 ± 1.2
EPA	238.9 ± 11.8	190.1 ± 10.2	343.6 ± 1	359.4 ± 12.6	323.6 ± 18.1
22:2n6	1.4 ± 0.1	1.5 ± 0.2	2.3 ± 0.2	1.7 ± 0.3	1.9 ± 0.3
22:4n6	3.2 ± 0.4	4.2 ± 0.2	3.3 ± 0.2	4.2 ± 0.8	4.1 ± 0.1
DPAn-3	65.2 ± 4.5	68.8 ± 2.7	96.9 ± 1.2	102.8 ± 4	85.4 ± 4.2
DHA	500.4 ± 32.7	343.8 ± 11.7	543.5 ± 1	589.1 ± 22.2	516.9 ± 3.2
Σ (n-3) FA	913.0	698.5	1122.4	1212.2	1092.7
Σ (n-6) FA	83.6	91.7	123.9	121.2	137.5
Σ PUFA	1006.5	800.3	1271.7	1374.8	1249.5
mg EPA + DHA in 8 oz	1676.6	1210.8	2011.8	2151.2	1906.3
oz to 1750 mg EPA + DHA	8.37	11.58	6.96	6.51	7.35

Common name *Latin name*	Scup *Stenotomus chrysops*		Sea Bass, Black *Centropristis stiata*		
Vendor Date Farm/Wild	MA1 Apr 2013 Wild	MA3 June 2013 Wild	GL1 Nov 2011 Wild	GL1 Aug 2012 Wild	SW1 Apr 2013 Wild
Location	Atlantic Ocean, USA	North Atlantic Ocean, USA	Atlantic Ocean	Virginia, USA	Pacific Ocean, USA
Fish 1	10.75 in, 1.31 lbs	11 in, 0.95 lbs	7.5 in, 0.7 lbs	11.25 in, 1.14 lbs	15 in, 1.5 lbs
Fish 2	10.75 in, 1.28 lbs	10 in, 0.75 lbs	9 in, 0.8 lbs	11 in, 1.54 lbs	14 in, 1 lb
Fish 3	10.5 in, 1.02 lbs	11 in, 0.9 lbs	8 in, 0.8 lbs		14 in, 1 lb
Moisture (%)	75.66 ± 0.08	80.51 ± 0.08	79.07 ± 0.2	82.31 ± 0.04	81.13 ± 0.39
Total Fat (%)	3.67 ± 0.02	1.04 ± 0.03	2.39 ± 0.11	1.06 ± 0.24	0.93 ± 0.00
Mercury (ppb)	210.00 ± 11.62	136.75 ± 7.46	111.52 ± 10.05	174.64 ± 2.78	129.72 ± 6.55
<u>FA (mg/100 g)</u>					
12:0	2.2 ± 0.2	-	2.9 ± 0.2	-	-
14:0	90 ± 3.7	13.3 ± 0.7	41.8 ± 4.2	9 ± 2.1	17.9 ± 0.3
16:0	616.9 ± 11.3	139.7 ± 2.4	301.4 ± 36.1	108.8 ± 12.8	181.2 ± 10.4
18:0	246.1 ± 4.1	61.8 ± 2.9	75.9 ± 8.9	37 ± 2.1	55 ± 1.6
20:0	8.3 ± 0.2	2.2 ± 0.2	2.6 ± 0.3	-	1.7 ± 0.1
22:0	3.7 ± 0.1	-	1.6 ± 0.2	-	1.2 ± 0
24:0	1.8 ± 0.2	1.1 ± 0.1	1 ± 0.1	5 ± 4.3	1 ± 0
Σ SFA	968.9	218.1	427.2	159.8	258.1
14:1n5	2.6 ± 0.1	-	1.8 ± 0.2	-	-
16:1n7	150.3 ± 2.4	21.2 ± 0.5	144.1 ± 17.8	35.4 ± 6.8	51.4 ± 0
18:1n7	90.1 ± 1.5	30.7 ± 1.7	52.4 ± 6.2	17.8 ± 1.9	27.6 ± 0.7
18:1n9	698.2 ± 2.7	70.2 ± 2.9	245 ± 32.7	57.7 ± 5.1	109.9 ± 1.1
20:1n9	54.7 ± 0.1	6.4 ± 0.6	19.2 ± 2.2	6.5 ± 1.1	7.1 ± 0.8
22:1n9	12.4 ± 0.3	1.9 ± 0.1	2.7 ± 0.2	1.4 ± 0.1	1.5 ± 0
24:1n9	11.3 ± 0.2	3.4 ± 0.1	3.6 ± 0	9.8 ± 5	4.2 ± 0.1
Σ MUFA	1019.7	133.7	468.9	128.5	201.7
16:2n4	5.6 ± 0.1	1.7 ± 0	2.5 ± 0.1	3.7 ± 0	2.4 ± 1.7
16:3n4	4.8 ± 0.1	1.6 ± 0.1	1.9 ± 0.1	-	-
LA	15.6 ± 0.3	6.3 ± 0.2	11.3 ± 1.1	5.6 ± 0.6	8.2 ± 0.4
ALA	6.9 ± 0	1.5 ± 0.1	5 ± 0.5	2.7 ± 0.4	3.3 ± 0.3
18:3n4	6.6 ± 0	1.5 ± 0	3.1 ± 0.4	2.5 ± 0.4	1.9 ± 0.2
18:3n6	1.8 ± 0.1	-	-	-	-
SDA	8.6 ± 0.3	3.3 ± 0.1	6.5 ± 0.4	3 ± 0.6	4 ± 0.4
20:2n6	9.2 ± 0.2	2.8 ± 0.2	5.4 ± 0.6	3.4 ± 0.4	2.9 ± 0.1
20:3n3	2.4 ± 0	-	1.7 ± 0.2	1.3 ± 0.2	-
20:3n6	4.2 ± 0	1.8 ± 0.1	1.6 ± 0.2	-	1.3 ± 0.1
20:4n3	8.4 ± 0.1	3.6 ± 0.1	5.3 ± 0.5	2.8 ± 0.2	3.2 ± 0.4
ARA	85.7 ± 0.9	35.5 ± 0.4	32.2 ± 3.5	18.4 ± 0.4	28.7 ± 0.7
EPA	185.1 ± 0.2	76.1 ± 1.1	123.9 ± 12.6	47.7 ± 4.8	71.8 ± 6.5
22:2n6	1.1 ± 0.1	-	-	-	-
22:4n6	27.6 ± 0.1	8.2 ± 0.3	7.4 ± 0.9	4.5 ± 0.1	7 ± 0.6
DPAn-3	105.9 ± 1.2	41.3 ± 1.7	36.5 ± 3.8	16.5 ± 0.8	26.8 ± 2.3
DHA	282.1 ± 4.5	175 ± 3.7	213.9 ± 21.7	190.8 ± 7.9	173.7 ± 19.6
Σ (n-3) FA	599.3	300.9	392.9	264.8	282.6
Σ (n-6) FA	145.2	54.5	57.7	31.9	48.1
Σ PUFA	761.6	360.2	458.1	302.8	335.1
mg EPA + DHA in 8 oz	1059.4	569.6	766.1	541.0	556.7
oz to 1750 mg EPA + DHA	13.22	24.59	18.37	25.92	25.30

Common name	Sea Bass, Chilean			Sea Bass, White	
Latin name	*Dissostichus eleginoides*			*Atractoscion nobilis*	
Vendor Date Farm/Wild	NW1 Apr 2013 Wild	SW1 Aug 2012 Wild	SW1 Apr 2013 Wild	SW1 Aug 2012 Wild	SW1 Mar 2013 Wild
Location	South Pacific Ocean, Chile	Chile	Pacific Ocean, Chile	Mexico	Pacific Ocean, USA
Fish 1	*44 in, *35 lbs	30 in	25 in, 14 lbs	*20-30 lbs	n/a
Fish 2	*48 in, *28 lbs	35 in	27 in, 17 lbs	*20-30 lbs	n/a
Fish 3	*50 in, *38 lbs	34 in	26 in, 15 lbs	*20-30 lbs	n/a
Moisture (%)	67.09 ± 0.81	66.29 ± 1.21	51.17 ± 2.36	77.91 ± 0.19	78.35 ± 0.1
Total Fat (%)	23.38 ± 1.57	28.09 ± 2.46	46.48 ± 0.60	0.87 ± 0.18	0.87 ± 0.03
Mercury (ppb)	643.76 ± 28.36	356.36 ± 26.69	100.74 ± 9.35	259.74 ± 6.59	410.68 ± 40.42
FA (mg/100 g)					
12:0	6.1 ± 0.3	6.2 ± 1.5	16.5 ± 0.1	-	-
14:0	666.4 ± 39.8	1559.3 ± 117.8	3328.3 ± 177.1	9.4 ± 2.1	2.9 ± 0.3
16:0	2292.6 ± 97.2	2195.2 ± 215.8	4417.6 ± 60.8	118 ± 11.4	71.8 ± 6.5
18:0	754.9 ± 29.1	314 ± 31.4	580.5 ± 21.1	42.1 ± 3	28.8 ± 1.6
20:0	24.9 ± 1.3	8.1 ± 0.7	14.2 ± 0.5	-	-
22:0	8.4 ± 0.8	4.5 ± 0.3	-	-	-
24:0	4.8 ± 0.4	2.5 ± 0.4	5.1 ± 0.6	-	-
Σ SFA	3758.2	4089.8	8362.2	169.6	103.4
14:1n5	47.4 ± 3.3	50.8 ± 1.4	183.3 ± 8.5	-	-
16:1n7	1375.8 ± 110.4	2551.3 ± 184.8	4972.9 ± 339.4	19 ± 3.8	5.2 ± 0.3
18:1n7	804.5 ± 46.4	1641.2 ± 136.9	2799.2 ± 68.1	11.1 ± 2	6.3 ± 0.3
18:1n9	7083.4 ± 353.8	8007 ± 899.8	10963.5 ± 423.6	48.6 ± 11.2	24.3 ± 0.9
20:1n9	1557.8 ± 123.7	1577.7 ± 149.6	1426.9 ± 18.4	6.5 ± 1.3	3.1 ± 0.1
22:1n9	289.5 ± 26.7	408.8 ± 23.5	389.3 ± 0.1	-	-
24:1n9	193.4 ± 21.4	132.3 ± 4.6	177.9 ± 11.8	3.9 ± 0.3	2 ± 0
Σ MUFA	11351.7	14369.3	20913.0	89.1	40.8
16:2n4	24.6 ± 3.2	41.9 ± 1.6	88.8 ± 2.9	-	-
16:3n4	6.8 ± 0.9	7.2 ± 0.5	11.9 ± 0.9	-	-
LA	128.1 ± 9.8	413.3 ± 32.4	752.8 ± 12.8	6.4 ± 1.9	3.7 ± 0.2
ALA	51.8 ± 4	107.9 ± 9.1	211 ± 6.7	1.5 ± 0.2	-
18:3n4	32 ± 1.7	14.6 ± 3.3	21.5 ± 0.6	-	-
18:3n6	9.3 ± 0.8	29.6 ± 2.4	55.5 ± 3.6	-	-
SDA	96.7 ± 9.1	182.4 ± 17.6	456.5 ± 17	2.5 ± 0.2	-
20:2n6	50.7 ± 2.5	37.6 ± 3.8	62.8 ± 0.7	-	-
20:3n3	27.9 ± 1.3	17.3 ± 1.6	40.4 ± 3.7	-	-
20:3n6	14.3 ± 0.6	11.7 ± 2	25.3 ± 0.2	-	-
20:4n3	87.9 ± 2.6	63.5 ± 0.7	92.6 ± 2.5	1.8 ± 0.2	-
ARA	118.4 ± 6.6	77.4 ± 5.1	189.1 ± 3.9	17.4 ± 0.9	16.9 ± 0.8
EPA	643.3 ± 13.8	682.8 ± 48.6	2503.2 ± 42.6	36.4 ± 1.3	17.8 ± 0.8
22:2n6	8.7 ± 0.9	6.9 ± 0.5	10.5 ± 0.2	-	-
22:4n6	22.6 ± 1.6	40.1 ± 3.1	47.6 ± 7.8	1.4 ± 0	2.2 ± 0.1
DPAn-3	109.4 ± 6.3	69.1 ± 5.5	128.6 ± 3.3	7.9 ± 0.6	7.8 ± 0.1
DHA	983 ± 4.2	631 ± 58.5	1846.4 ± 23.2	177 ± 3.4	137.2 ± 3.3
Σ (n-3) FA	1999.9	1753.9	5278.7	227.0	162.8
Σ (n-6) FA	352.0	616.6	1143.7	25.2	22.7
Σ PUFA	2415.4	2434.2	6544.7	252.2	185.5
mg EPA + DHA in 8 oz	3688.4	2979.5	9864.8	484.0	351.7
oz to 1750 mg EPA + DHA	3.80	4.72	1.42	28.94	39.83

Common name	Seatrout, Spotted	Shad, American	Shark, Common Thresher	Shark, Spiny Dogfish	
Latin name	*Cynoscion nebulosus*	*Alosa sapidissima*	*Alopias vulpinus*	*Squalus acanthias*	
Vendor	SE1	NE5	SW1	MA3	MA2
Date	Dec 2012	June 2013	Aug 2012	June 2013	July 2013
Farm/Wild	Wild	Wild	Wild	Wild	Wild
Location	Gulf of Mexico, USA	Connecticut River, USA	California, USA	Gulf of Maine, USA	North Atlantic Ocean, USA
Fish 1	18 in	n/a	*60+ in, *40+ lbs	22.25 in, 2.05 lbs	22 in, 4 lbs
Fish 2	18 in	n/a	*60+ in, *40+ lbs	22 in, 2.25 lbs	
Fish 3		n/a	*60+ in, *40+ lbs	24.25 in, 2.3 lbs	
Moisture (%)	77.47 ± 0.13	76.13 ± 0.28	75.99 ± 0.32	74.08 ± 0.28	80.51 ± 0.21
Total Fat (%)	4.54 ± 0.10	3.16 ± 0.03	0.77 ± 0.02	7.92 ± 0.55	0.76 ± 0.08
Mercury (ppb)	103.47 ± 3.93	56.76 ± 2.59	296.39 ± 7.96	433.13 ± 10.82	161.43 ± 5.38
FA (mg/100 g)					
12:0	2.1 ± 0	-	-	-	-
14:0	149 ± 2.6	132 ± 1.4	4 ± 0	101.7 ± 5.7	1.9 ± 0
16:0	865.7 ± 16.6	441.4 ± 10.4	107 ± 2.2	1231.9 ± 51.6	46.1 ± 1
18:0	178.6 ± 3.5	77.6 ± 2.1	53.7 ± 1	219.2 ± 11.1	45 ± 0.3
20:0	8.1 ± 0.2	5.8 ± 0.1	-	5.9 ± 0.2	-
22:0	5.2 ± 0.1	1.4 ± 0.1	-	-	-
24:0	5.4 ± 0	1.2 ± 0.1	-	1.2 ± 0	-
Σ SFA	1214.1	659.3	164.6	1559.9	93.1
14:1n5	3.5 ± 0.1	-	-	1 ± 0	-
16:1n7	488.9 ± 12.7	56.8 ± 1.2	9.7 ± 0.2	240.8 ± 10	25.4 ± 0.6
18:1n7	122.6 ± 3.3	62.5 ± 1.1	37.2 ± 0.8	264.9 ± 7.7	29.1 ± 0.2
18:1n9	427.4 ± 12.5	199.4 ± 5	34.8 ± 5.4	1093.5 ± 5.7	87 ± 0.4
20:1n9	16.2 ± 0.9	482.7 ± 22.1	5.5 ± 0.3	553.9 ± 15.7	3.5 ± 0
22:1n9	4.7 ± 0.2	26.7 ± 0.3	-	144.7 ± 1.3	-
24:1n9	8.3 ± 0.4	27.5 ± 1.1	1.3 ± 0.1	12.1 ± 1.9	-
Σ MUFA	1071.5	855.5	88.5	2311.0	145.0
16:2n4	31.4 ± 0.6	6.3 ± 0.2	-	10 ± 0.3	-
16:3n4	19.2 ± 0.4	3.9 ± 0.1	-	3.8 ± 0	-
LA	84.8 ± 2	30.3 ± 0.7	3.4 ± 1.8	119.9 ± 4	10.7 ± 0.1
ALA	65.9 ± 1.4	17.1 ± 0.5	-	48.6 ± 2.2	-
18:3n4	13.1 ± 0.4	3.1 ± 0	-	12.4 ± 0.5	-
18:3n6	20.9 ± 0.5	2.6 ± 0.1	-	6.9 ± 0.6	-
SDA	40.8 ± 0.9	31.6 ± 0.8	-	64.1 ± 3.1	-
20:2n6	12.7 ± 0.2	6.5 ± 0.1	1.5 ± 0	26.3 ± 1.1	49.3 ± 0.3
20:3n3	10.5 ± 0.4	5.2 ± 0	-	10 ± 0.3	-
20:3n6	16.3 ± 0.2	2.2 ± 0.1	-	7.9 ± 0.2	-
20:4n3	27.1 ± 0.8	24.1 ± 0.6	1.4 ± 0	49.5 ± 2.4	-
ARA	123.4 ± 2.1	17.8 ± 0.5	27.9 ± 0.4	175.2 ± 6.9	4.4 ± 0
EPA	191.2 ± 4.2	132.9 ± 3.3	12.7 ± 0	447.9 ± 23.5	5 ± 0.1
22:2n6	-	-	-	2.4 ± 0.1	13.3 ± 0.1
22:4n6	35.3 ± 0.8	2.8 ± 0.2	9.2 ± 0.2	37.4 ± 2.1	1.8 ± 0.1
DPAn-3	87 ± 2.1	45.3 ± 0.8	38.2 ± 0.5	156.9 ± 9.1	6.2 ± 0.2
DHA	381.6 ± 4.3	469.6 ± 14.7	165.8 ± 2.6	1411.5 ± 91.6	22.3 ± 0.2
Σ (n-3) FA	804.0	725.8	218.1	2188.4	33.5
Σ (n-6) FA	293.5	62.2	41.9	375.9	79.5
Σ PUFA	1161.2	801.2	260.1	2590.6	113.0
mg EPA + DHA in 8 oz	1298.9	1366.6	404.9	4216.9	62.1
oz to 1750 mg EPA + DHA	10.78	10.25	34.59	3.33	225.78

Common name *Latin name*	Skate *Rajidae spp.*		Smelt, Rainbow *Osmerus mordax*		Snapper, Red *Lutjanus campechanus*	
Vendor Date Farm/Wild	MA2 July 2013 Wild	MA3 June 2013 Wild	GL1 Jan 2011 Wild	GL1 Aug 2012 Wild	GL1 Jan 2011 Wild	NE1 Dec 2012 Wild
Location	Atlantic Ocean, USA	North Atlantic Ocean, USA	Lake Michigan	Great Lakes	Gulf of Mexico	Costa Rica
Fish 1	10 in, 1 lbs	15.5 in, 2.1 lbs	*3 in, *<0.25 lbs	*3 in, *<0.25 lbs	7 in, 0.95 lbs	n/a
Fish 2	10 in, 1 lbs	15.5 in, 1.55 lbs	*3 in, *<0.25 lbs	*3 in, *<0.25 lbs	8 in, 1 lb	n/a
Fish 3	10 in, 1 lbs	14.5 in, 1.55 lbs	*3 in, *<0.25 lbs	*3 in, *<0.25 lbs	8.5 in, 1.6 lbs	
Moisture (%)	80.02 ± 0.27	77.76 ± 0.03	82.66 ± 0.21	82.90 ± 0.45	79.30 ± 0.05	79.06 ± 0.09
Total Fat (%)	0.80 ± 0.01	0.79 ± 0.17	2.47 ± 0.25	1.87 ± 0.00	1.08 ± 0.01	0.93 ± 0.00
Mercury (ppb)	83.07 ± 8.50	98.94 ± 7.22	16.33 ± 1.63	16.48 ± 0.11	95.35 ± 5.92	17.92 ± 0.82
<u>FA (mg/100 g)</u>						
12:0	-	-	1.7 ± 0	-	-	-
14:0	4.2 ± 0	3.8 ± 0.1	87 ± 8.7	74.4 ± 2.3	7.7 ± 0.3	5.5 ± 0.7
16:0	121.6 ± 2.9	107.4 ± 8.9	351.5 ± 31.5	281.7 ± 11.8	107.4 ± 3.4	115.5 ± 12
18:0	25.4 ± 1.1	22.9 ± 2	47 ± 4.4	52.9 ± 1.9	43 ± 1.6	48.4 ± 6.3
20:0	-	-	2.4 ± 0.2	2.2 ± 0.1	1.5 ± 0	1.8 ± 0.3
22:0	-	-	-	1.6 ± 0.3	-	-
24:0	-	-	1.4 ± 0.3	1.8 ± 0.1	1 ± 0	1.2 ± 0.1
Σ SFA	151.2	134.1	490.9	414.5	160.6	172.4
14:1n5	-	-	1.9 ± 0.1	2.4 ± 0.1	-	-
16:1n7	9 ± 0.1	10.4 ± 0.4	118.5 ± 11.5	103.5 ± 6.6	13.5 ± 0.7	9.3 ± 1.2
18:1n7	17.3 ± 0.6	18.2 ± 1.6	68.9 ± 6.6	58.9 ± 3.3	11.9 ± 0.4	12.2 ± 1.8
18:1n9	35.2 ± 1.5	37.8 ± 3.6	234.7 ± 21.2	230.5 ± 13.7	51 ± 2.1	38.7 ± 5
20:1n9	5.3 ± 0.3	6.9 ± 0.5	14.2 ± 1.5	3.3 ± 0.2	2.2 ± 0.1	3.2 ± 0.4
22:1n9	-	-	3.3 ± 0.8	1.4 ± 0.1	-	1.3 ± 0.1
24:1n9	1.1 ± 0	1.2 ± 0	8.3 ± 2.4	6.4 ± 0.2	1.2 ± 0	1.9 ± 0
Σ MUFA	67.9	74.3	449.7	406.4	79.9	66.7
16:2n4	-	-	6.7 ± 0.6	4.6 ± 0.8	-	2.5 ± 0.4
16:3n4	-	-	3.6 ± 0.4	3.1 ± 0.1	-	-
LA	6.7 ± 0.3	6.5 ± 0.4	89.9 ± 9.4	88.9 ± 5.8	4.2 ± 0.1	6.3 ± 0.8
ALA	1.8 ± 0.1	1.8 ± 0	72.1 ± 7.4	104.6 ± 11.6	1.1 ± 0	1.3 ± 0.2
18:3n4	-	-	3 ± 0.2	-	-	-
18:3n6	-	-	5.7 ± 0.5	5.7 ± 0.3	-	-
SDA	1.2 ± 0.1	1.4 ± 0	35.6 ± 3.7	81.2 ± 6.6	-	-
20:2n6	1.7 ± 0.1	1.9 ± 0.1	22.8 ± 2.4	4.3 ± 0.2	1.5 ± 0.1	3.3 ± 0.5
20:3n3	-	-	28.4 ± 2.9	3.6 ± 0.2	-	-
20:3n6	-	-	3.9 ± 0	1.9 ± 0.1	-	-
20:4n3	3.1 ± 0.1	3.2 ± 0.1	35.1 ± 3.9	9.4 ± 0.7	-	1.5 ± 0.2
ARA	18.8 ± 0.8	16.3 ± 1.6	74.7 ± 7.8	70.9 ± 3.3	24.2 ± 0.7	24.8 ± 2.9
EPA	33.9 ± 1.4	30.2 ± 2.7	171.5 ± 18.3	174.9 ± 12.6	21.2 ± 0.7	26.7 ± 3.2
22:2n6	-	-	6.5 ± 0.9	-	-	-
22:4n6	3.8 ± 0.7	3.4 ± 0.4	9.1 ± 2.5	7 ± 1	5.7 ± 0.2	4.8 ± 0.5
DPAn-3	20.9 ± 0.9	19 ± 1.1	37.6 ± 4.4	13.7 ± 0.4	12.1 ± 0.4	12.1 ± 1.5
DHA	143.3 ± 7.4	135.1 ± 10.9	311.6 ± 32.2	184.3 ± 10	119.4 ± 3.5	180.2 ± 19.5
Σ (n-3) FA	204.1	190.7	691.9	571.8	153.8	221.8
Σ (n-6) FA	30.9	28.0	212.7	178.7	35.7	39.2
Σ PUFA	235.0	218.7	917.9	758.2	189.4	263.5
mg EPA + DHA in 8 oz	401.7	374.9	1095.7	814.7	318.7	469.2
oz to 1750 mg EPA + DHA	34.90	37.47	12.85	17.22	43.95	30.03

Common name	Snapper, Red				
Latin name	*Lutjanus campechanus*				
Vendor Date Farm/Wild	NE5 June 2013 Wild	SE2 Nov 2012 Wild	SE1 Apr 2013 Wild	SW1 Aug 2012 Wild	SW1 Apr 2013 Wild
Location	Gulf of Mexico, Panama	Gulf of Mexico, Mexico	Gulf of Mexico, Mexico	Canada	Atlantic Ocean, Canada
Fish 1	n/a	13 in, 1.2 lbs	n/a	n/a	n/a
Fish 2	n/a	13 in, 1.1 lbs	n/a	n/a	n/a
Fish 3	n/a	13 in, 1.1 lbs	n/a	n/a	n/a
Moisture (%)	79.17 ± 0.29	78.72 ± 0.16	78.15 ± 0.13	78.35 ± 0.20	80.68 ± 0.33
Total Fat (%)	1.60 ± 0.20	0.69 ± 0.13	1.57 ± 0.11	1.79 ± 0.22	1.05 ± 0.07
Mercury (ppb)	93.28 ± 2.18	123.37 ± 8.50	294.14 ± 27.12	88.00 ± 4.19	91.80 ± 1.70
FA (mg/100 g)					
12:0	-	-	-	-	-
14:0	35 ± 3.9	3.6 ± 1	33.2 ± 5.8	55.4 ± 0	24.1 ± 0.7
16:0	298.3 ± 26.7	99.7 ± 13.5	130 ± 10.5	288.6 ± 3.6	172.3 ± 13
18:0	127.2 ± 11.5	41.3 ± 5.6	52.7 ± 2	58.7 ± 2.1	39.8 ± 4.4
20:0	4.6 ± 0.4	-	1.5 ± 0.2	2 ± 0.2	-
22:0	3 ± 0.2	-	1.5 ± 0.3	1.1 ± 0.2	-
24:0	4.3 ± 0.1	1.1 ± 0.2	1.6 ± 0.2	-	-
Σ SFA	472.3	145.7	220.5	405.7	236.2
14:1n5	-	-	1.5 ± 0.4	1.1 ± 0	-
16:1n7	44.7 ± 4.6	9.5 ± 1.2	24.4 ± 4.8	83.6 ± 2.4	31.7 ± 1.1
18:1n7	31.8 ± 2.8	9.1 ± 1	13.4 ± 1.8	67.6 ± 1.4	33.1 ± 3.3
18:1n9	179.8 ± 16	43.8 ± 1.8	91.4 ± 8.5	235.2 ± 11.5	88.4 ± 6.1
20:1n9	5.9 ± 0.5	3 ± 0.7	2.8 ± 0.4	40.6 ± 6.6	14.3 ± 0.8
22:1n9	2.6 ± 0.1	-	-	8 ± 0.3	12.6 ± 0.3
24:1n9	8.3 ± 0.5	2 ± 0.2	4.3 ± 0.4	10.4 ± 1.5	6.5 ± 0.5
Σ MUFA	273.0	67.4	137.8	446.5	186.6
16:2n4	1.9 ± 0.2	2.2 ± 0.4	-	6 ± 0.3	3.3 ± 0
16:3n4	1 ± 0.1	-	-	4 ± 0	2.9 ± 0.2
LA	12 ± 1	4.3 ± 0.4	6.9 ± 0.5	20.8 ± 0.5	8.9 ± 0.7
ALA	5.9 ± 0.4	-	1.9 ± 0.5	11.8 ± 0.9	3.1 ± 0.2
18:3n4	3.5 ± 0.4	-	-	2.2 ± 0.3	1.1 ± 0.1
18:3n6	1.3 ± 0.1	-	-	1.4 ± 0	-
SDA	5.4 ± 0.6	-	1.2 ± 0.3	26.4 ± 0.6	7.4 ± 0.1
20:2n6	2.7 ± 0.2	1.5 ± 0.1	1.6 ± 0.2	2.9 ± 0.2	1.6 ± 0.1
20:3n3	1.2 ± 0.1	-	-	1.7 ± 0.1	-
20:3n6	2.1 ± 0.1	-	1.5 ± 0	1.2 ± 0	-
20:4n3	5.4 ± 0.6	-	1.5 ± 0.2	8.5 ± 0.3	2.8 ± 0.3
ARA	44.5 ± 3.4	21.5 ± 2.2	40.4 ± 0.5	19.1 ± 0.1	12.3 ± 1
EPA	61.1 ± 5.1	12.6 ± 1.4	15.4 ± 1	164.4 ± 0.6	91.2 ± 5.1
22:2n6	-	-	-	-	-
22:4n6	8.7 ± 1.2	5.3 ± 0.4	11 ± 0	-	-
DPAn-3	23.9 ± 1.8	9.3 ± 1.1	12.6 ± 0.7	20.7 ± 0.3	15.2 ± 2.2
DHA	280.6 ± 17.3	154.7 ± 16.8	138.8 ± 0.7	279.3 ± 7.9	240.8 ± 24.3
Σ (n-3) FA	383.5	176.6	171.3	512.7	360.4
Σ (n-6) FA	71.3	32.7	61.4	45.3	22.8
Σ PUFA	461.2	211.5	232.7	570.2	390.5
mg EPA + DHA in 8 oz	775.1	379.5	349.8	1006.3	752.9
oz to 1750 mg EPA + DHA	18.10	37.12	40.03	13.92	18.67

Common name	Snapper, Vermilion		Snapper, Yellowtail		
Latin name	*Rhomboplites aurorubens*		*Ocyurus chrysurus*		
Vendor Date Farm/Wild	SE1 Oct 2012 Wild	SE1 Aug 2013 Wild	SE3 Oct 2012 Wild	SE1 Oct 2012 Wild	SE1 May 2013 Wild
Location	Gulf of Mexico, USA	Gulf of Mexico, USA	Atlantic Ocean, USA	Gulf of Mexico, USA	Gulf of Mexico, USA
Fish 1	n/a	15 in	1.25 lbs	18 in	11 in
Fish 2	n/a	13 in	1.25 lbs	17.5 in	10.5 in
Fish 3	n/a	13.5 in	1.25 lbs		11.5 in
Moisture (%)	80.16 ± 0.27	77.66 ± 0.11	78.64 ± 0.30	78.24 ± 0.33	77.18 ± 0.15
Total Fat (%)	0.82 ± 0.04	1.26 ± 0.14	0.67 ± 0.09	0.93 ± 0.01	2.14 ± 0.08
Mercury (ppb)	60.72 ± 2.43	64.79 ± 1.11	67.78 ± 1.35	70.11 ± 1.83	64.86 ± 1.12
FA (mg/100 g)					
12:0	-	-	-	-	-
14:0	5.6 ± 2.3	37.7 ± 1.3	15.3 ± 7.1	16.8 ± 5	48.7 ± 0.4
16:0	115.4 ± 11.7	205.2 ± 6	106.2 ± 16.5	109.3 ± 16.3	382.3 ± 6
18:0	42.7 ± 4.9	80.2 ± 1.9	38.9 ± 3.6	43 ± 6.3	126.3 ± 3.6
20:0	-	3.8 ± 0.1	1.6 ± 0.5	1.7 ± 0.3	11.2 ± 0.4
22:0	-	1.7 ± 0	-	1.1 ± 0.1	6.2 ± 0.1
24:0	-	1.7 ± 0.1	1.1 ± 0	1.2 ± 0	4.3 ± 0.3
Σ SFA	163.8	330.4	163.1	173.0	579.0
14:1n5	-	-	-	-	-
16:1n7	10.5 ± 3.1	35.4 ± 0.4	13.8 ± 4.9	18.1 ± 4.7	77.4 ± 1
18:1n7	8 ± 1.5	21.4 ± 0.6	7.6 ± 1.7	8.7 ± 1.7	30.3 ± 0.9
18:1n9	46.5 ± 10	69.5 ± 1.9	42.8 ± 9.9	37.4 ± 5.1	177.8 ± 3.8
20:1n9	5.5 ± 2	4 ± 0.2	1.6 ± 0.7	2.2 ± 0.3	9.2 ± 0.2
22:1n9	-	3.9 ± 0.2	-	-	4.3 ± 0.1
24:1n9	1.9 ± 0.2	5.9 ± 0.1	1.7 ± 0.5	2.2 ± 0.1	10.3 ± 0.8
Σ MUFA	72.4	140.1	67.5	68.6	309.4
16:2n4	-	1.7 ± 0	-	1.3 ± 0.4	1.8 ± 0
16:3n4	-	1.1 ± 0.1	1.9 ± 0.5	1.2 ± 0.3	4.9 ± 6.4
LA	4.3 ± 0.5	12.3 ± 0.4	9.9 ± 1.4	8.9 ± 1.5	20.2 ± 0.9
ALA	-	5.2 ± 0.1	2.3 ± 0.7	2.5 ± 0.5	10.6 ± 0.6
18:3n4	1.3 ± 0.1	1.9 ± 0	1.3 ± 0.2	1.4 ± 0.2	4.7 ± 0.1
18:3n6	-	1.6 ± 0.1	-	-	2.1 ± 0.2
SDA	-	5.9 ± 0.1	1.7 ± 0.6	2.9 ± 0.7	5.2 ± 0.3
20:2n6	1.8 ± 0.3	2.6 ± 0.1	1.4 ± 0.2	1.5 ± 0.3	5.2 ± 0.3
20:3n3	-	-	-	-	2.2 ± 0.1
20:3n6	-	1.5 ± 0.1	-	-	2.2 ± 0.2
20:4n3	-	3 ± 0.2	1.9 ± 0.4	2.1 ± 0.5	6.8 ± 0.8
ARA	20.7 ± 1.5	31.4 ± 2.3	21.2 ± 0.1	22 ± 1.6	41.1 ± 3.9
EPA	15.1 ± 3	49.4 ± 2.9	18 ± 2.1	20.7 ± 3.1	68 ± 7.5
22:2n6	-	-	-	-	-
22:4n6	4.9 ± 0.4	4.4 ± 0.3	4.7 ± 0.4	3.1 ± 0.5	11.2 ± 2.4
DPAn-3	10.9 ± 1.5	15.2 ± 1.9	6.5 ± 0.8	6.2 ± 0.9	29.5 ± 3.5
DHA	175.1 ± 8.3	238.3 ± 26.6	149.8 ± 4.8	120.9 ± 4.6	362 ± 51.4
Σ (n-3) FA	201.1	317.1	180.1	155.2	484.3
Σ (n-6) FA	31.8	53.8	37.1	35.5	82.0
Σ PUFA	234.2	375.6	220.4	194.6	577.7
mg EPA + DHA in 8 oz	431.3	652.6	380.5	321.2	975.3
oz to 1750 mg EPA + DHA	32.52	21.57	36.80	43.66	14.49

Common name *Latin name*	Spot *Leiostomus xanthurus*		Sturgeon, Green *Acipenser medirostris*	Sturgeon, White *Acipenser transmontanus*	
Vendor Date Farm/Wild	MA1 Apr 2013 Wild	MA2 July 2013 Wild	NW1 Apr 2013 Farm	NW1 Oct 2012 Farm	NW1 Feb 2013 Wild
Location	Atlantic Ocean, USA	Chesapeake Bay, USA	USA, fresh water	California, USA, pond raised	USA
Fish 1	8 in, 0.45 lbs	4 in, 0.2 lbs	*25 in, *10 lbs	33 in, 12.2 lbs	*41 in, *18 lbs
Fish 2	7.75 in, 0.33 lbs	5 in, 0.3 lbs	*27 in, *12 lbs	33.5 in, 12.8 lbs	*42 in, *15 lbs
Fish 3	8 in, 0.38 lbs	5 in, 0.3 lbs	*24 in, *12 lbs	35 in, 14 lbs	*45 in, *20 lbs
Moisture (%)	65.81 ± 2.88	74.94 ± 0.16	88.09 ± 1.02	70.26 ± 4.31	75.72 ± 0.45
Total Fat (%)	16.04 ± 0.35	7.26 ± 0.09	14.78 ± 1.20	11.16 ± 0.16	7.27 ± 0.07
Mercury (ppb)	30.17 ± 0.47	43.02 ± 2.73	15.68 ± 1.61	16.38 ± 1.31	63.30 ± 1.55
<u>FA (mg/100 g)</u>					
12:0	17.5 ± 0.6	5.2 ± 0.2	4.1 ± 0.6	3.1 ± 0.2	37.8 ± 1.2
14:0	392.2 ± 6.2	127.5 ± 2.5	368.3 ± 36.7	328.7 ± 6.3	139.4 ± 5.1
16:0	4059 ± 12.9	1685.7 ± 24.6	2303.5 ± 205.8	2060.7 ± 35.8	1205.1 ± 57.8
18:0	860.2 ± 25.5	382.5 ± 5.1	347.3 ± 20.5	284.8 ± 6.2	148 ± 4.3
20:0	37.9 ± 0.6	18.3 ± 0.3	10.7 ± 0.9	10.2 ± 0.4	5 ± 0.1
22:0	23 ± 0.1	6.7 ± 0.2	4.8 ± 0.5	4 ± 0.3	3.4 ± 0.2
24:0	7.4 ± 0.3	3.1 ± 0.1	3.7 ± 0.6	3.9 ± 0.3	3.9 ± 0
Σ SFA	5397.3	2229.0	3042.5	2695.4	1542.4
14:1n5	9 ± 0	4.3 ± 0.2	7.6 ± 1.4	6.1 ± 0.9	5.2 ± 0.4
16:1n7	1292.1 ± 4.6	693.1 ± 11.5	647.9 ± 63.7	600.2 ± 13.4	516.7 ± 17.2
18:1n7	421.1 ± 8.1	226.9 ± 2	367.8 ± 29.5	275.6 ± 23.5	406.3 ± 15.5
18:1n9	3003.2 ± 114	1198.7 ± 10.5	3982.6 ± 331.2	3262.7 ± 79	1563.8 ± 31.6
20:1n9	153.7 ± 34.7	71.3 ± 0.6	173.8 ± 12.2	132.4 ± 0.6	113.2 ± 106.1
22:1n9	26 ± 0.5	10.8 ± 0.7	13.9 ± 1.3	12.7 ± 0.2	8.4 ± 0
24:1n9	16 ± 1	4.6 ± 0.6	8.7 ± 1.5	10.6 ± 1.2	2.1 ± 0.1
Σ MUFA	4921.2	2209.8	5202.2	4300.2	2615.7
16:2n4	24.8 ± 1.8	4.6 ± 0.1	36.3 ± 3.6	33.9 ± 3	38.4 ± 1.4
16:3n4	20.2 ± 1.3	3.2 ± 0.2	24.5 ± 1.8	24.9 ± 1.6	21.3 ± 0.5
LA	115.1 ± 1.1	29.2 ± 0.2	1331.1 ± 115.3	1108.7 ± 30.6	161.2 ± 3.6
ALA	61.4 ± 0.8	14.6 ± 0.2	83.9 ± 8.2	79.6 ± 2.5	131.2 ± 4.9
18:3n4	17.9 ± 0.3	4.8 ± 0.3	36.6 ± 5.9	31.3 ± 4.2	48.8 ± 1.9
18:3n6	7.9 ± 0.5	1.8 ± 0.1	92.8 ± 8.8	47.7 ± 1.8	11.7 ± 0.1
SDA	74.6 ± 0.8	8.6 ± 0.4	49.6 ± 4.5	47.8 ± 1.9	65.3 ± 2
20:2n6	53.1 ± 2.1	21.5 ± 0.4	71.2 ± 5	54.8 ± 2.6	58.2 ± 1.5
20:3n3	22.3 ± 0.1	6.9 ± 0.1	10.3 ± 0.9	9.3 ± 0.3	26.5 ± 1.7
20:3n6	12.4 ± 0	5.7 ± 0.1	59.9 ± 4.5	29.1 ± 0.8	31.9 ± 0.4
20:4n3	52.3 ± 0.1	10.4 ± 0.4	46.1 ± 4	46.2 ± 1	78 ± 1.9
ARA	176 ± 1.6	78.9 ± 1.5	178 ± 10.3	112.1 ± 1.7	225.7 ± 7.4
EPA	628.7 ± 8.9	340.9 ± 5.8	403.5 ± 29.2	409.6 ± 8.9	511.1 ± 15.5
22:2n6	3.3 ± 1.1	1.7 ± 0.1	5.1 ± 0.8	5 ± 0.7	1.9 ± 0
22:4n6	70.1 ± 1.1	63.4 ± 1.5	31.9 ± 2.3	19.1 ± 0.2	51.5 ± 1.9
DPAn-3	256.3 ± 0.7	181.9 ± 2.5	171.6 ± 12.4	155.4 ± 2.9	161.4 ± 6.7
DHA	730 ± 14.5	198.2 ± 3.4	662.5 ± 41.2	528.9 ± 4.9	155.8 ± 5
Σ (n-3) FA	1825.7	761.6	1427.6	1276.7	1129.3
Σ (n-6) FA	438.0	202.3	1770.1	1376.5	542.0
Σ PUFA	2326.5	976.4	3295.1	2743.3	1779.8
mg EPA + DHA in 8 oz	3081.5	1222.6	2417.8	2128.6	1512.4
oz to 1750 mg EPA + DHA	4.55	11.45	5.80	6.58	9.26

Common name	Swordfish				
Latin name	*Xiphias gladius*				
Vendor Date Farm/Wild	GL1 Nov 2010 Wild	NW1 Oct 2012 Wild	NE1 Nov 2012 Wild	NE3 Oct 2012 Wild	NE4 May 2013 Wild
Location	Gulf of Mexico/ Atlantic Ocean	Pacific Ocean, Costa Rica	Brazil	Atlantic Ocean, Canada	Atlantic/Pacific; Costa Rica/USA,Brazil
Fish 1	50 in, 111 lbs	n/a	67 in, 200 lbs	120 lbs	50 in, 119 lbs
Fish 2	58 in, 116 lbs	n/a	63 in, 187 lbs	120 lbs	54 in, 146 lbs
Fish 3	42 in, 78 lbs	n/a	70 in, 311 lbs	110 lbs	65 in, 200 lbs
Moisture (%)	76.89 ± 0.14	77.78 ± 0.10	74.27 ± 0.22	69.98 ± 0.31	77.98 ± 0.42
Total Fat (%)	2.42 ± 0.00	3.34 ± 0.35	7.26 ± 0.58	10.25 ± 0.36	5.19 ± 0.31
Mercury (ppb)	703.90 ± 40.13	1718.95 ± 138.14	925.74 ± 87.66	987.99 ± 26.35	1637.81 ± 39.81
FA (mg/100 g)					
12:0	-	-	-	3.9 ± 0.2	-
14:0	53.8 ± 2.5	50 ± 3.5	135.2 ± 5.4	374.4 ± 26.7	97.2 ± 4
16:0	404.8 ± 12.3	488 ± 24.8	790.1 ± 41.5	1472.5 ± 76.7	709.5 ± 19.8
18:0	141.3 ± 0.4	163.9 ± 6.5	221.2 ± 11	419.2 ± 24.6	275.8 ± 11.4
20:0	8.3 ± 0	8.9 ± 0.2	13.1 ± 0.8	13.1 ± 0.8	12.9 ± 0.4
22:0	5.1 ± 0.1	5.8 ± 0.1	6.7 ± 0.4	-	6.4 ± 0.2
24:0	3.7 ± 0.2	4.9 ± 0.3	4.6 ± 0.3	2.2 ± 0.2	4.4 ± 0
Σ SFA	617.0	721.6	1170.8	2285.2	1106.2
14:1n5	-	1.4 ± 0.1	2.6 ± 0.1	11.8 ± 6.5	2 ± 0
16:1n7	75.9 ± 0.9	110.1 ± 6.2	216.3 ± 11	624 ± 37.9	162.2 ± 5.3
18:1n7	58.6 ± 1.9	88.9 ± 3.5	144.9 ± 1.8	305.5 ± 18.1	114.4 ± 3.6
18:1n9	593.1 ± 5.3	988.3 ± 42.2	1601.1 ± 121.2	1925.4 ± 113.1	1565.3 ± 64
20:1n9	98.3 ± 7.4	130.8 ± 3.2	383.7 ± 16.3	855.4 ± 47.9	346.3 ± 18.3
22:1n9	17.9 ± 0.7	18 ± 0.6	56.2 ± 2.1	137.3 ± 38.4	210.3 ± 12.6
24:1n9	26.5 ± 0.3	38.1 ± 3.7	59.6 ± 0.9	76.4 ± 13.4	71.1 ± 2.6
Σ MUFA	870.3	1375.5	2464.6	3935.7	2471.7
16:2n4	1.5 ± 0.1	-	41.7 ± 1.6	24.3 ± 1.6	28.2 ± 0.5
16:3n4	-	-	39.9 ± 4.9	6.5 ± 0	31.3 ± 0.8
LA	13 ± 0.2	11.9 ± 1	44.1 ± 2	107 ± 6.6	28.2 ± 1.1
ALA	3.8 ± 0.1	4.9 ± 4	13.8 ± 0.2	56.1 ± 3.5	5.4 ± 0.4
18:3n4	8.4 ± 0.1	7.3 ± 0.4	16.7 ± 0	12.9 ± 0.5	10.7 ± 0.1
18:3n6	-	-	1.9 ± 0.1	5.3 ± 0.1	-
SDA	1.4 ± 0.1	-	8 ± 0.5	80.1 ± 5.1	1.9 ± 0.5
20:2n6	6.3 ± 0.3	5.8 ± 0.3	13.4 ± 0.4	22.8 ± 1.5	10.1 ± 0.3
20:3n3	4.5 ± 0.1	5.3 ± 0.2	9.3 ± 0.1	15.1 ± 1.2	6.1 ± 0
20:3n6	2.4 ± 0.1	2.3 ± 0.2	4.4 ± 0.2	8.1 ± 0.2	3.7 ± 0.1
20:4n3	5.5 ± 0.1	4.6 ± 0.4	37.2 ± 0.6	86.8 ± 4.2	9.2 ± 0.7
ARA	40.8 ± 0.9	40.1 ± 1.3	41.5 ± 1.6	42.1 ± 1.6	42.3 ± 0.2
EPA	49.2 ± 2.4	27 ± 1.6	74.4 ± 0.2	510.5 ± 28	44.6 ± 2.6
22:2n6	-	-	1.4 ± 0.1	1.8 ± 0.1	1.4 ± 0
22:4n6	16.3 ± 0.2	19 ± 1.6	19.4 ± 1.1	10.8 ± 0.6	19.7 ± 0.2
DPAn-3	52.1 ± 1.1	45.4 ± 1.5	96.1 ± 2.2	205.8 ± 13	79.7 ± 3.5
DHA	282.8 ± 12.1	239.8 ± 16.4	418.7 ± 12.6	892.9 ± 37.9	315.3 ± 4.6
Σ (n-3) FA	399.2	326.9	657.4	1847.1	462.3
Σ (n-6) FA	78.7	79.1	126.2	197.8	105.4
Σ PUFA	487.9	413.3	881.9	2088.6	637.9
mg EPA + DHA in 8 oz	752.8	605.1	1118.3	3182.7	816.3
oz to 1750 mg EPA + DHA	18.62	23.19	12.53	4.41	17.16

Common name *Latin name*	Swordfish *Xiphias gladius*				
Vendor Date Farm/Wild	NW1 Mar 2013 Wild	SE1 Sept 2012 Wild	SE1 Apr 2013 Wild	SW1 Aug 2012 Wild	SW1 Apr 2013 Wild
Location	Pacific Ocean, Fiji	Atlantic Ocean, USA	South Atlantic Ocean, USA	Marto, Ecuador	Pacific Ocean, Mexico
Fish 1	*96-120 in, *120 lbs	*<100 lbs	n/a	*125-130 lbs	n/a
Fish 2	*96-120 in, *120 lbs	*<100 lbs	n/a	*125-130 lbs	n/a
Fish 3	*96-120 in, *120 lbs	*<100 lbs	n/a	*125-130 lbs	n/a
Moisture (%)	78.76 ± 0.09	76.78 ± 0.10	71.90 ± 0.17	73.30 ± 0.20	67.53 ± 2.52
Total Fat (%)	1.77 ± 0.17	2.97 ± 0.15	9.26 ± 0.54	8.70 ± 0.16	15.00 ± 0.45
Mercury (ppb)	883.70 ± 11.32	1134.11 ± 56.47	1239.80 ± 52.98	1283.17 ± 40.41	1230.32 ± 42.04
FA (mg/100 g)					
12:0	-	-	1.8 ± 0.1	1.6 ± 0.1	3.1 ± 0.5
14:0	27.3 ± 1	50.8 ± 2	276.1 ± 14.1	170.6 ± 9.1	337 ± 1.6
16:0	246.9 ± 0.6	506.4 ± 22.2	1436.7 ± 67.1	1373 ± 67	1902 ± 19.7
18:0	89.2 ± 2.4	153.3 ± 6.2	426.2 ± 20.6	423 ± 4.8	764.8 ± 4.2
20:0	5 ± 0.3	7.7 ± 0.4	24 ± 1.3	23 ± 1.2	43.5 ± 0.5
22:0	3.7 ± 0.3	4.7 ± 0.4	14.4 ± 1.2	12.9 ± 1.1	20.5 ± 0.2
24:0	3.3 ± 0.2	4.1 ± 0	6.7 ± 0.3	6.6 ± 0.4	13 ± 1
Σ SFA	375.3	727.0	2185.9	2010.6	3083.8
14:1n5	-	1.6 ± 0	6.7 ± 0.5	4.8 ± 0.1	6.2 ± 0.4
16:1n7	45.2 ± 0.6	86.3 ± 4.2	391.9 ± 20.9	240.6 ± 15.5	476.9 ± 10.9
18:1n7	35.5 ± 0.6	64.8 ± 2.6	228.9 ± 1.5	192 ± 0.7	390.4 ± 7.1
18:1n9	394.6 ± 14.6	864.3 ± 41.5	2656.5 ± 142.9	2724.8 ± 29	4635.2 ± 47.3
20:1n9	54.8 ± 3.3	117 ± 4.7	402.6 ± 22.1	456.9 ± 13.5	1183.6 ± 17.5
22:1n9	8.9 ± 0.6	18.1 ± 0.8	62 ± 2.8	63.2 ± 1.8	146.4 ± 3
24:1n9	23.1 ± 1.4	35.1 ± 1.4	97.2 ± 0.5	69.7 ± 7.9	185.4 ± 3.7
Σ MUFA	562.0	1187.3	3845.7	3752.1	7024.2
16:2n4	-	20.8 ± 1.4	9.3 ± 0.2	46.2 ± 2.6	9.1 ± 0.4
16:3n4	-	18.9 ± 0.7	-	46.5 ± 4.2	-
LA	11.4 ± 0.3	12.2 ± 0.8	85.2 ± 4.9	23.5 ± 1.9	96 ± 0.3
ALA	2 ± 0.1	2.7 ± 0.1	36.3 ± 1.9	18.7 ± 0.9	28.4 ± 0.4
18:3n4	5.2 ± 0	7.9 ± 0.4	27.5 ± 0.8	17.6 ± 1.1	37 ± 0.8
18:3n6	-	-	4.3 ± 1	1.4 ± 0.3	5.2 ± 0.5
SDA	1 ± 0	-	28 ± 1.2	-	13.9 ± 0.1
20:2n6	2.8 ± 0.1	5.7 ± 0.1	25.4 ± 1.5	24.9 ± 0.8	33.9 ± 1.7
20:3n3	1.7 ± 0.1	6.2 ± 0.2	19.3 ± 0.9	18.2 ± 0.7	22.6 ± 1.9
20:3n6	1.3 ± 0.1	1.7 ± 0	8.3 ± 0.3	5.7 ± 0.3	10 ± 0.3
20:4n3	4.2 ± 0	4.2 ± 0.3	80.3 ± 3.9	13.2 ± 0.8	59 ± 0.7
ARA	29.5 ± 0.2	46.4 ± 1.7	78.6 ± 2.9	85 ± 2.6	106 ± 3.2
EPA	17.6 ± 0.1	50 ± 2	164.9 ± 7.6	134.5 ± 2.1	204 ± 10.4
22:2n6	-	-	2.8 ± 0.2	3.3 ± 0.1	4.5 ± 0.2
22:4n6	8.3 ± 0.1	16.4 ± 0.6	40.7 ± 2	38.5 ± 1.7	59.4 ± 0.1
DPAn-3	20.2 ± 0.6	52.6 ± 1.8	202.2 ± 10	148.3 ± 6	277.2 ± 3.8
DHA	159.6 ± 2.2	403.7 ± 14.2	1005.8 ± 49.8	840 ± 16.9	950.4 ± 30.4
Σ (n-3) FA	206.4	519.5	1536.8	1173.0	1555.4
Σ (n-6) FA	53.3	82.4	245.4	182.4	314.9
Σ PUFA	264.9	649.5	1819.1	1465.8	1916.4
mg EPA + DHA in 8 oz	401.9	1029.2	2655.2	2210.3	2618.1
oz to 1750 mg EPA + DHA	34.84	13.62	5.28	6.34	5.35

Common name	Swordfish		Tilapia		
Latin name	*Xiphias gladius*		*Tilapiini, spp.*		
Vendor Date Farm/Wild	MA2 July 2013 Wild	MA3 June/July 2013 Wild	GL1 Oct 2010 Farm	GL1 Aug 2012 Farm	NW1 Oct 2012 Farm
Location	Pacific Ocean, Ecuador	Atlantic Ocean	Honduras	Honduras	Chile
Fish 1	50 in, 136 lbs	n/a	n/a	n/a	10 in, 2 lbs
Fish 2	61 in, 154 lbs	n/a	n/a	n/a	10 in, 2 lbs
Fish 3	46 in, 120 lbs	n/a	n/a	n/a	10 in, 2 lbs
Moisture (%)	72.27 ± 0.95	75.73 ± 0.29	76.64 ± 0.06	76.02 ± 0.13	83.37 ± 0.76
Total Fat (%)	10.53 ± 0.45	5.18 ± 0.23	3.55 ± 0.18	4.33 ± 0.09	1.51 ± 0.13
Mercury (ppb)	525.69 ± 19.76	1007.88 ± 29.74	3.34 ± 0.43	14.32 ± 1.99	2.04 ± 0.40
FA (mg/100 g)					
12:0	1.5 ± 0.2	1 ± 0	36.1 ± 2.3	31.3 ± 1.3	2 ± 0.2
14:0	203.6 ± 12.7	125.6 ± 2.1	158.3 ± 8.5	128.1 ± 0.8	33 ± 3.8
16:0	1665.1 ± 33.2	755.3 ± 8.5	885 ± 44.5	878.3 ± 24.8	266.7 ± 20.6
18:0	491 ± 37.9	218.6 ± 4	215 ± 10.3	216.4 ± 8.1	73.5 ± 4.3
20:0	35.9 ± 6.1	10.6 ± 0.2	6 ± 0.4	6 ± 0.2	2.6 ± 0.3
22:0	18.7 ± 2.8	5.2 ± 0.4	3.2 ± 0.3	3 ± 0.1	1.7 ± 0
24:0	6.6 ± 1.3	3.9 ± 0.1	2 ± 0.1	2 ± 0.3	1.4 ± 0.1
Σ SFA	2422.5	1120.1	1305.7	1265.0	380.9
14:1n5	6.5 ± 1.1	3.1 ± 0.1	6.2 ± 0.3	4.9 ± 0.2	1.4 ± 0.2
16:1n7	409.2 ± 3.9	245.2 ± 5.7	193.8 ± 12	160.4 ± 4.1	53.6 ± 6
18:1n7	284.2 ± 35.9	141.2 ± 3.9	97.7 ± 2.3	87.5 ± 0.6	46.2 ± 4.6
18:1n9	3480.8 ± 37.6	1415.9 ± 25.9	953.3 ± 51.4	987.1 ± 39.9	258.4 ± 25.9
20:1n9	679.3 ± 109.2	375 ± 6.1	43.7 ± 2.3	41.8 ± 2	13.3 ± 1.3
22:1n9	99.8 ± 18.2	53.4 ± 2.2	2.6 ± 0.5	2.1 ± 0.3	3.7 ± 0.3
24:1n9	90.9 ± 16.6	55.3 ± 1.9	1.9 ± 0.1	1.1 ± 0.2	1.2 ± 0
Σ MUFA	5050.6	2289.1	1299.2	1285.0	377.7
16:2n4	2.7 ± 0.1	6.7 ± 0.3	4.5 ± 0.2	-	-
16:3n4	-	1.6 ± 0.1	3.7 ± 0.2	-	-
LA	46.2 ± 1.4	37.9 ± 0.6	509.6 ± 21.4	487.2 ± 17.3	135.7 ± 16
ALA	12.6 ± 0.8	16.7 ± 0.4	34.2 ± 1.5	28.3 ± 0.9	15.8 ± 2.5
18:3n4	21.9 ± 8.2	10.9 ± 0.1	4 ± 0.2	1.1 ± 0	-
18:3n6	2.7 ± 0.5	-	24.8 ± 1.1	26.9 ± 0.7	8.6 ± 1.2
SDA	4.4 ± 0.8	11.1 ± 0.1	4.8 ± 0.2	1.5 ± 0	1.6 ± 0.1
20:2n6	35.1 ± 0.9	9.4 ± 0.1	23.1 ± 0.5	25 ± 1	7.3 ± 0.5
20:3n3	26.2 ± 2.6	7.1 ± 0.1	4.8 ± 0.3	4.9 ± 0.2	2.6 ± 0.4
20:3n6	8.7 ± 0.4	3.5 ± 0.2	29.7 ± 0.7	30.1 ± 1	9.9 ± 0.8
20:4n3	22.2 ± 1	24.9 ± 0.6	4.6 ± 0.3	1.9 ± 0.1	1.6 ± 0.2
ARA	121.9 ± 4.5	39.9 ± 1.3	49.9 ± 0.3	57.1 ± 1.8	35.7 ± 2.8
EPA	179.6 ± 25.6	101.1 ± 4	10.8 ± 0.3	3.3 ± 0.2	5.8 ± 0.3
22:2n6	4 ± 0.4	-	-	4.2 ± 0.1	-
22:4n6	75.7 ± 14.9	14.2 ± 0.2	22.5 ± 0.5	30.6 ± 0.9	11.9 ± 1.3
DPAn-3	212.5 ± 0.4	86.6 ± 3	47.3 ± 1.1	17.4 ± 0.5	14.7 ± 1.1
DHA	1007.1 ± 121.9	371.7 ± 10.6	113 ± 0.5	60.7 ± 2	42 ± 3.7
Σ (n-3) FA	1464.5	619.1	219.6	117.9	84.2
Σ (n-6) FA	294.2	105.0	659.7	661.1	209.0
Σ PUFA	1783.4	743.3	891.5	780.1	293.2
mg EPA + DHA in 8 oz	2691.5	1072.2	280.8	145.0	108.6
oz to 1750 mg EPA + DHA	5.24	13.07	49.85	96.59	129.43

Common name	Tilapia					
Latin name	*Tilapiini, spp.*					
Vendor Date Farm/Wild	NE1 Cec 2012 Farm	NE3 Oct 2012 Farm	NE2 May 2013 Farm	NW1 Mar 2013 Farm	SE1 Sept 2012 Farm	SE1 Mar 2013 Farm
Location	Ecuador	Ecuador	China	China	Ecuador	Panama
Fish 1	n/a	n/a	n/a	n/a	n/a	n/a
Fish 2	n/a	n/a	n/a	n/a	n/a	n/a
Fish 3	n/a	n/a	n/a	n/a	n/a	n/a
Moisture (%)	78.43 ± 0.07	77.67 ± 0.27	81.18 ± 0.35	83.24 ± 0.35	78.20 ± 0.45	78.81 ± 0.38
Total Fat (%)	1.92 ± 0.05	2.44 ± 0.10	2.55 ± 0.04	1.37 ± 0.16	3.17 ± 0.14	2.77 ± 0.23
Mercury (ppb)	67.86 ± 1.94	9.51 ± 1.19	1.52 ± 0.22	1.60 ± 0.47	13.20 ± 0.73	42.03 ± 0.98
FA (mg/100 g)						
12:0	1.3 ± 0.2	1.9 ± 0.2	6.7 ± 0.8	1.9 ± 0.7	2.8 ± 0.2	7.8 ± 1.3
14:0	52.8 ± 4.7	69.1 ± 6.7	62.9 ± 3.2	32.6 ± 7.4	102.4 ± 9.1	72.8 ± 9.8
16:0	457.1 ± 39	541.6 ± 14.6	546.5 ± 36.7	297.3 ± 47.5	713.7 ± 69.9	481.8 ± 58.3
18:0	122.7 ± 8.7	140.8 ± 3	154.7 ± 10.9	79.6 ± 9.2	181.5 ± 19.8	128.4 ± 12.9
20:0	3.4 ± 0.2	3.9 ± 0.3	4.5 ± 0.3	3.5 ± 0.6	6.6 ± 0.8	4.3 ± 0.4
22:0	1.5 ± 0.2	2.3 ± 0.1	2.3 ± 0.3	1.9 ± 0.2	2.7 ± 0.3	2.4 ± 0.1
24:0	1.4 ± 0.1	1.6 ± 0.1	1.8 ± 0.2	1.5 ± 0	1.8 ± 0.2	1.8 ± 0.2
Σ SFA	640.2	761.2	779.5	418.3	1011.5	699.2
14:1n5	2.9 ± 0.3	2.5 ± 0.3	2.2 ± 0.1	1.1 ± 0.2	5.5 ± 0.6	2.1 ± 0.2
16:1n7	97.1 ± 8.4	101.2 ± 4.8	95.1 ± 6.7	51.2 ± 8.8	164 ± 16.9	68.8 ± 8.8
18:1n7	57.2 ± 5.2	64 ± 2.5	75.7 ± 6	42.1 ± 7.5	92.3 ± 9.9	49.3 ± 4.8
18:1n9	546 ± 55.9	525.5 ± 20.8	610.5 ± 41.3	330 ± 53.7	929.9 ± 101.8	475.4 ± 47.4
20:1n9	28.1 ± 2.7	29.4 ± 0.2	30.7 ± 1.4	16.1 ± 2.8	48.8 ± 6.1	25.5 ± 2.5
22:1n9	1.1 ± 0	2 ± 0.2	2.7 ± 1	1.6 ± 0.4	2 ± 0.3	1.6 ± 0
24:1n9	1.2 ± 0.1	1.5 ± 0.1	1.4 ± 0.1	1.1 ± 0.1	1.6 ± 0.2	1.6 ± 0.1
Σ MUFA	733.5	726.1	818.2	443.4	1244.1	624.1
16:2n4	-	2.2 ± 0.1	1.2 ± 0.1	-	2.4 ± 0.2	-
16:3n4	-	1.8 ± 0.1	-	-	2.1 ± 0	-
LA	169.3 ± 15.3	264.4 ± 16	289.4 ± 20	177.5 ± 28.6	347.1 ± 35	275.9 ± 27.4
ALA	8.5 ± 0.6	21 ± 0.5	27.6 ± 2.5	17.5 ± 3.2	21.8 ± 2.2	18 ± 2
18:3n4	-	2.3 ± 0.3	-	-	2.5 ± 0	1.3 ± 0
18:3n6	12.1 ± 1.3	13.3 ± 1.1	16.8 ± 0.4	8.8 ± 1.6	20.7 ± 0.3	10.9 ± 1
SDA	1.4 ± 0	2.1 ± 0	3.9 ± 0.2	4.8 ± 0.6	2.4 ± 0.4	2.4 ± 0.4
20:2n6	7.6 ± 0.4	15.5 ± 0.8	13.3 ± 1.1	9.4 ± 1.5	14 ± 1.7	18.5 ± 1.4
20:3n3	1.2 ± 0.1	4.3 ± 0.1	4 ± 0.4	3 ± 0.6	2.7 ± 0.3	4.3 ± 0.4
20:3n6	12.5 ± 0.6	18 ± 1.8	19 ± 1.1	11.5 ± 1.2	20.3 ± 2	20 ± 1.7
20:4n3	1 ± 0.1	2.7 ± 0.1	3.1 ± 0.2	2.9 ± 0.3	3 ± 0.1	3.1 ± 0.4
ARA	32.6 ± 0.4	37.4 ± 1.9	37.2 ± 3	30.9 ± 1.4	36.2 ± 3.1	41.7 ± 3.2
EPA	4 ± 0.1	4.4 ± 0	5.4 ± 0.3	7.5 ± 0.2	8.1 ± 0.5	5.5 ± 0.2
22:2n6	3.6 ± 0.3	-	-	-	4 ± 0.5	1.1 ± 0.1
22:4n6	13.5 ± 0.7	20 ± 1	17.7 ± 1.1	11.4 ± 1	18.5 ± 1.6	18.2 ± 1.3
DPAn-3	9.3 ± 0.3	19 ± 0.3	18.4 ± 0.9	16.6 ± 0.7	28.7 ± 2.7	21.9 ± 1.8
DHA	71.3 ± 2.7	71.3 ± 0.7	64.3 ± 5.6	53.4 ± 0.7	100 ± 8.1	80.2 ± 4.9
Σ (n-3) FA	96.7	124.8	126.7	105.8	166.7	135.4
Σ (n-6) FA	251.2	368.6	393.4	249.5	460.9	386.3
Σ PUFA	347.9	499.6	521.2	355.3	634.6	523.0
mg EPA + DHA in 8 oz	170.7	171.7	158.1	138.2	245.2	194.5
oz to 1750 mg EPA + DHA	82.08	81.56	88.90	101.36	57.30	72.13

Common name	Tilapia		Tilefish		Trout, Lake	
Latin name	*Tilapiini, spp.*		*Lopholatilus chamaeleonticeps*		*Salvelinus namaycush*	
Vendor	SW1	SW1	SE1	NE2	GL1	GL1
Date	Aug 2012	Apr 2013	May 2013	Jan 2012	Nov 2011	Oct 2012
Farm/Wild	Farm	Farm	Wild	Wild	Wild	Wild
Location	Ecuador	Ecuador	Gulf of Mexico, USA	Hudson Canyon, New York, USA	Lake Michigan	Lake Michigan
Fish 1	n/a	n/a	21.5 in	*20 in, *5 lbs	17 in, 3 lbs	16 in, 2.08 lbs
Fish 2	n/a	n/a	22 in	*20 in, *5 lbs	13.5 in, 2.15 lbs	18 in, 2.18 lbs
Fish 3	n/a	n/a	22 in	*15 in, *2 lbs	13 in, 2.1 lbs	17 in, 1.86 lbs
Moisture (%)	80.32 ± 0.13	78.91 ± 0.27	82.44 ± 0.03	81.09 ± 0.2	73.98 ± 0.32	78.44 ± 0.03
Total Fat (%)	1.71 ± 0.35	1.84 ± 0.09	0.51 ± 0.00	0.79 ± 0.17	7.17 ± 0.04	3.78 ± 0.10
Mercury (ppb)	15.95 ± 0.63	4.42 ± 0.29	426.61 ± 12.74	704.84 ± 34.66	57.18 ± 1.08	90.75 ± 2.06
<u>FA (mg/100 g)</u>						
12:0	-	18.1 ± 1.4	-	-	3.8 ± 0.2	1.9 ± 0.2
14:0	29.8 ± 4	56.7 ± 9.2	2.8 ± 0.4	5 ± 0.7	212.6 ± 8	85.3 ± 4.3
16:0	243 ± 29.7	398.8 ± 50.8	77.5 ± 0.1	87.2 ± 4.8	1037.7 ± 39.5	590.3 ± 24.2
18:0	69.6 ± 8.2	88.2 ± 9.4	22.7 ± 0.2	23.2 ± 1.2	202.7 ± 8.9	152.1 ± 6.2
20:0	2 ± 0.2	4.1 ± 0.7	-	-	9.2 ± 0.4	5.5 ± 0.1
22:0	1.4 ± 0.1	2.2 ± 0.4	-	-	3.7 ± 0	3.5 ± 0.1
24:0	1.2 ± 0.2	2 ± 0.7	-	-	2.1 ± 0.4	2.9 ± 0.1
Σ SFA	347.1	570.2	103.0	115.4	1471.8	841.4
14:1n5	1.2 ± 0.1	2 ± 0.3	-	-	6.7 ± 0.2	2.8 ± 0.1
16:1n7	45.2 ± 5	75.5 ± 10.8	6.9 ± 0.3	15.1 ± 1.5	647.7 ± 28.4	295.5 ± 11
18:1n7	30.7 ± 3.4	48.2 ± 6.7	6.5 ± 0.1	10.2 ± 0.7	258.6 ± 5.6	158.6 ± 5.5
18:1n9	199.6 ± 19.9	411.3 ± 53.8	30.5 ± 0.3	50.4 ± 3.6	1247.6 ± 56.6	832.1 ± 23.3
20:1n9	12 ± 1.2	22 ± 3.1	2.4 ± 0.1	4.3 ± 0.6	54.6 ± 2	35.2 ± 0.9
22:1n9	1.2 ± 0.2	1.6 ± 0.3	-	-	10.6 ± 0.5	6 ± 0
24:1n9	1.3 ± 0.4	1.4 ± 0.1	2 ± 0.2	2.3 ± 0.1	4.7 ± 1.1	13.3 ± 0.3
Σ MUFA	291.2	562.0	48.4	82.3	2230.5	1343.6
16:2n4	1.3 ± 0.3	1.7 ± 0.3	1.7 ± 0.2	-	28.2 ± 0.8	7.1 ± 0.4
16:3n4	-	-	1.2 ± 0	-	14.8 ± 0.7	2.6 ± 0.1
LA	106.8 ± 11.5	181.8 ± 22.1	2.2 ± 0	2.7 ± 0.7	224.8 ± 8.7	107.8 ± 2.1
ALA	8 ± 0.9	18.7 ± 2.5	-	-	164.8 ± 6.7	64.3 ± 0.5
18:3n4	1.1 ± 0.1	1.5 ± 0.2	-	-	18.1 ± 1	5.1 ± 0
18:3n6	6.1 ± 0.6	6.3 ± 0.6	-	-	13.4 ± 0.5	5 ± 0.2
SDA	-	3 ± 0.4	-	-	72.4 ± 3.2	24.9 ± 0
20:2n6	7 ± 0.8	11 ± 1.3	-	-	56.4 ± 2.2	17.6 ± 0.1
20:3n3	1.7 ± 0.2	4.1 ± 0.6	-	-	60.1 ± 2.1	11.8 ± 0
20:3n6	11 ± 1.3	11.4 ± 0.9	-	-	21 ± 0.8	8.7 ± 0.1
20:4n3	1.2 ± 0.2	3.2 ± 0.4	-	-	119.1 ± 4.2	30.3 ± 0.7
ARA	33.1 ± 4.2	28.3 ± 2.2	18.1 ± 0.5	17.9 ± 1	172.3 ± 6.6	99.1 ± 0.1
EPA	4.4 ± 0.5	5.9 ± 0.5	12.5 ± 0.1	11.8 ± 1	306.7 ± 11.1	160.6 ± 1.1
22:2n6	-	-	-	-	14.6 ± 0.5	3.3 ± 0.1
22:4n6	12.2 ± 1.1	13 ± 1.3	3.8 ± 0.1	6.2 ± 0.2	47.2 ± 2.5	26.2 ± 0.9
DPAn-3	13.1 ± 1.9	20.5 ± 2.1	10.4 ± 0.1	16.5 ± 1.9	178.1 ± 7.5	97.4 ± 1.9
DHA	48.4 ± 5	69.1 ± 6	140.9 ± 3.8	122.5 ± 3.2	795.9 ± 36.1	345.1 ± 8.9
Σ (n-3) FA	76.7	124.5	163.7	150.7	1697.2	734.3
Σ (n-6) FA	176.2	251.7	24.1	26.9	549.7	267.7
Σ PUFA	255.2	379.4	190.8	177.6	2308.0	1016.8
mg EPA + DHA in 8 oz	119.8	170.2	347.8	304.6	2500.8	1146.9
oz to 1750 mg EPA + DHA	117.56	82.57	40.27	46.00	5.60	12.21

Common name *Latin name*	Trout, Rainbow *Oncorhynchus mykiss*				
Vendor Date Farm/Wild	GL1 Oct 2010 Farm	GL1 Aug 2012 Farm	NW1 Sept 2012 Farm	NE1 Dec 2012 Farm	NE5 June 2013 Farm
Location	Idaho, USA	Wisconsin, USA	Idaho, USA	Idaho, USA	Idaho, USA
Fish 1	n/a	10.5 in, 0.58 lbs	12 in, 0.87 lbs	n/a	n/a
Fish 2	n/a	10.25 in, 0.52 lbs	14 in, 1.2 lbs	n/a	n/a
Fish 3	n/a	10.75 in, 0.58 lbs	12 in, 1 lb	n/a	n/a
Moisture (%)	72.54 ± 0.41	76.94 ± 0.16	71.69 ± 0.3	72.4 ± 0.83	75.18 ± 0.41
Total Fat (%)	7.50 ± 1.22	3.15 ± 0.06	8.53 ± 0.11	5.55 ± 0.22	5.21 ± 0.61
Mercury (ppb)	43.92 ± 2.30	16.50 ± 0.33	13.72 ± 0.80	32.02 ± 0.08	32.88 ± 1.16
FA (mg/100 g)					
12:0	4.5 ± 0.2	2.3 ± 0.1	4 ± 0.1	2.2 ± 0.3	1.7 ± 0.2
14:0	299.4 ± 14.7	151.3 ± 2	144.8 ± 2.2	235.3 ± 12.6	142.5 ± 15.6
16:0	1239.5 ± 53.3	536.9 ± 9.7	1658 ± 56.5	1043.8 ± 61.3	808.7 ± 79.6
18:0	291.6 ± 12.4	119.9 ± 2.4	501.9 ± 22.7	237.2 ± 14.6	190 ± 20.2
20:0	9.4 ± 0.5	3.5 ± 0.2	11.3 ± 0.5	6.9 ± 0.5	4.8 ± 0.6
22:0	4.9 ± 0.2	2.2 ± 0.1	5.7 ± 0.3	5.9 ± 2.6	2.5 ± 0.3
24:0	3.4 ± 0.4	1.8 ± 0.1	4.8 ± 0.1	3.2 ± 0.2	2.9 ± 0.1
Σ SFA	1852.7	817.9	2330.6	1534.5	1153.2
14:1n5	2.1 ± 0.2	1.3 ± 0	5.3 ± 0.2	2.6 ± 0.1	1.1 ± 0.2
16:1n7	463.3 ± 22.7	251.7 ± 3.7	382.9 ± 13.8	396.9 ± 16.7	250.1 ± 30.5
18:1n7	231.9 ± 9.9	91.4 ± 1.6	210.2 ± 8.7	200.8 ± 9.4	143.1 ± 16.6
18:1n9	1082.1 ± 52.1	360.8 ± 6.1	2658.3 ± 125.2	1048.3 ± 47.5	975.7 ± 129.6
20:1n9	111.1 ± 1.7	22.2 ± 0.5	130.5 ± 5	96.4 ± 4.9	60.9 ± 8.9
22:1n9	17.8 ± 1.4	4.1 ± 0.1	14.4 ± 0.9	14.4 ± 0.6	9.3 ± 1.1
24:1n9	5.5 ± 0.1	2.7 ± 1.2	12.8 ± 0.3	14 ± 10.3	15.2 ± 1
Σ MUFA	1913.9	734.2	3414.5	1773.3	1455.5
16:2n4	37.7 ± 1.8	22.2 ± 0.5	8.3 ± 0.2	28.8 ± 1.2	18.4 ± 2.2
16:3n4	25.9 ± 1.1	16.9 ± 0.4	4.9 ± 0.1	18.1 ± 0.2	12.8 ± 1.3
LA	334.5 ± 16.5	158.5 ± 2.5	1259.4 ± 48.2	325.5 ± 13.8	315.3 ± 40.9
ALA	55.9 ± 6.4	27.7 ± 0.4	89.4 ± 2.5	46 ± 2.8	38.9 ± 4.6
18:3n4	28.4 ± 1.6	18.7 ± 0.3	10.5 ± 0.2	21.5 ± 0.1	13.6 ± 1.5
18:3n6	8.7 ± 0.3	5 ± 0.1	26.2 ± 1.1	8 ± 0.2	6.4 ± 0.7
SDA	55.5 ± 3.1	27.1 ± 0.8	18.6 ± 0.9	49 ± 1.9	29.4 ± 3.7
20:2n6	24.7 ± 1.2	8.3 ± 0.1	84.7 ± 3.3	22.6 ± 1	23.1 ± 3.1
20:3n3	8 ± 0.2	2.9 ± 0	7.4 ± 0.3	6.5 ± 0.5	5.4 ± 0.5
20:3n6	17.8 ± 0.8	9 ± 0.2	80.6 ± 3	15.5 ± 0.9	17.4 ± 2
20:4n3	53.7 ± 2.6	26.7 ± 0.4	18.4 ± 0.7	45.8 ± 2.2	28.8 ± 3.4
ARA	73.5 ± 3.4	35.4 ± 0.6	67.7 ± 1.9	52.9 ± 2.5	45.2 ± 4
EPA	492 ± 25.6	227 ± 3.4	72.4 ± 1.7	350.3 ± 13.2	225.2 ± 22.3
22:2n6	2.7 ± 0.4	-	7.9 ± 0.1	2.1 ± 0.2	2.7 ± 0.2
22:4n6	10.9 ± 1.2	6.5 ± 0.1	10.4 ± 0.2	8.4 ± 1	6.8 ± 0.8
DPAn-3	187.9 ± 9	89.6 ± 1.7	25.5 ± 0.9	140 ± 5.2	97.5 ± 10.6
DHA	955.7 ± 47.5	452.3 ± 7.8	417.7 ± 14.2	774.8 ± 19.2	636.3 ± 51.7
Σ (n-3) FA	1808.7	853.3	649.3	1412.4	1061.5
Σ (n-6) FA	472.7	222.6	1536.8	435.0	416.8
Σ PUFA	2373.5	1133.7	2209.7	1915.8	1523.1
mg EPA + DHA in 8 oz	3283.3	1540.8	1111.5	2551.8	1953.9
oz to 1750 mg EPA + DHA	4.27	9.09	12.60	5.49	7.19

Common name	Trout, Rainbow				
Latin name	*Oncorhynchus mykiss*				
Vendor Date Farm/Wild	NW1 Mar 2013 Farm	SE1 Sept 2012 Farm	SW1 Aug 2012 Farm	SW1 Apr 2013 Farm	SE1 Mar 2013 Wild
Location	USA	Columbia, fresh water	Idaho, USA	USA	Columbia, fresh water
Fish 1	14 in, 0.9 lbs	1.5 lbs	14 in, 0.99 lbs	n/a	n/a
Fish 2	15 in, 0.95 lbs	1.5 lbs	13 in, 0.8 lbs	n/a	n/a
Fish 3	15 in, 1 lb	1.5 lbs	12 in, 0.7 lbs	n/a	n/a
Moisture (%)	73.2 ± 0.5	72.93 ± 0.08	74.51 ± 0.2	74.94 ± 0.1	75.45 ± 0.17
Total Fat (%)	4.84 ± 0.15	8.22 ± 0.25	4.18 ± 0.29	5.14 ± 0.22	4.67 ± 0.41
Mercury (ppb)	10.08 ± 1.03	18.14 ± 0.81	26.20 ± 1.43	32.47 ± 2.55	10.08 ± 0.99
<u>FA (mg/100 g)</u>					
12:0	3 ± 0.3	5.8 ± 0.3	-	1.9 ± 0	2.5 ± 0.2
14:0	155 ± 10.1	156.7 ± 6.6	77 ± 4.4	166.1 ± 3.2	97 ± 5.6
16:0	969.4 ± 49.3	1173.3 ± 45.8	520.1 ± 21.9	927.3 ± 14.7	801 ± 49.1
18:0	240 ± 10.3	339.9 ± 10.6	120.6 ± 4	209.3 ± 3.3	230.1 ± 14
20:0	5.6 ± 0.1	9 ± 0.2	2.6 ± 0.1	5.2 ± 0.1	4.8 ± 0.2
22:0	3 ± 0.1	5 ± 0.1	1.7 ± 0	2.8 ± 0	2.4 ± 0.4
24:0	2.6 ± 0.1	4.1 ± 0.2	1.6 ± 0	2.8 ± 0.2	2 ± 0.1
Σ SFA	1378.6	1693.7	723.6	1315.3	1139.8
14:1n5	3.5 ± 0.2	4.3 ± 0.3	-	1.4 ± 0	3 ± 0.2
16:1n7	312.4 ± 16.1	299.4 ± 9.1	142.1 ± 4.9	274.7 ± 7.9	208.2 ± 13.3
18:1n7	123.9 ± 5.3	153.1 ± 4.3	89.8 ± 2.8	157.7 ± 3.3	106.7 ± 4.6
18:1n9	1131.8 ± 45.7	1372.2 ± 31.5	693.1 ± 18.5	1090.4 ± 30.4	1077.3 ± 63.4
20:1n9	52.5 ± 1.8	68 ± 1	44.4 ± 0.9	74 ± 1.4	47.6 ± 2.4
22:1n9	6.2 ± 0	7.8 ± 0.1	5.8 ± 0	11 ± 0.6	5 ± 0.2
24:1n9	9.5 ± 0.3	8.6 ± 1.3	3.9 ± 1.2	14.2 ± 0.1	6.3 ± 0.1
Σ MUFA	1639.8	1913.4	979.1	1623.3	1454.2
16:2n4	16.6 ± 0.8	8.7 ± 0.5	8.7 ± 0.2	20.2 ± 0.5	6 ± 0.2
16:3n4	12.2 ± 0.9	4.3 ± 0.1	5.7 ± 0.3	13.1 ± 0.2	4.2 ± 0.3
LA	575 ± 21.2	707.1 ± 16.3	235.7 ± 4.7	330.1 ± 9	526.5 ± 29.1
ALA	43 ± 1.4	68.4 ± 1.3	25.8 ± 0.4	41.9 ± 1.3	35 ± 1.9
18:3n4	15.4 ± 0.6	10.7 ± 0.1	7.6 ± 0.4	15 ± 0.1	6.8 ± 0.1
18:3n6	10.1 ± 0.4	13.7 ± 0.2	5.8 ± 0.1	7.1 ± 0.1	13.7 ± 1.1
SDA	25.8 ± 1.2	24.7 ± 0.4	17 ± 0	36.3 ± 1.1	11.9 ± 0.7
20:2n6	27.1 ± 0.8	38 ± 0.3	18.3 ± 0.1	24.6 ± 0.8	34.6 ± 2.3
20:3n3	3.6 ± 0	6.6 ± 0.1	3.4 ± 0.1	5.9 ± 0.2	3 ± 0.2
20:3n6	20.7 ± 0.3	23.7 ± 0.2	12.9 ± 0.2	18.3 ± 0.6	35.5 ± 2.5
20:4n3	22.1 ± 0.7	18.9 ± 0.3	13.6 ± 0	36.3 ± 0.7	10.6 ± 0.7
ARA	48.6 ± 1.2	64.9 ± 1	29.5 ± 0.3	44.7 ± 0.6	44.6 ± 1.7
EPA	154.2 ± 3.5	144.6 ± 2.3	130.2 ± 1	262.8 ± 4.3	63.5 ± 3.2
22:2n6	2.9 ± 0	3.5 ± 0.2	1.7 ± 0.1	2.7 ± 0.1	3.2 ± 0.2
22:4n6	7.6 ± 0.3	10.6 ± 0.2	4.1 ± 0.1	6.8 ± 0.3	7.1 ± 0.4
DPAn-3	61.1 ± 1.6	54.2 ± 0.6	47.3 ± 0.1	95.2 ± 2.1	25.8 ± 1.1
DHA	425.7 ± 8.1	627.8 ± 7.6	445.2 ± 2.3	648.1 ± 1	263.9 ± 9.3
Σ (n-3) FA	735.4	945.2	682.5	1126.6	413.6
Σ (n-6) FA	692.1	861.5	308.1	434.4	665.1
Σ PUFA	1471.7	1830.4	1012.6	1609.3	1095.8
mg EPA + DHA in 8 oz	1315.1	1751.9	1305.2	2066.1	742.6
oz to 1750 mg EPA + DHA	10.65	7.99	10.73	6.78	18.87

Common name	Tuna, Albacore			Tuna, Bluefin	Tuna, Yellowfin
Latin name	*Thunnus alalunga*			*Thunnus thunnus, spp.*	*Thunnus albacares*
Vendor	NW1	NW1	SW1	GL1	NE1
Date	Oct 2012	Mar 2013	Apr 2013	Aug 2011	Nov 2012
Farm/Wild	Wild	Wild	Wild	Wild	Wild
Location	Pacific Ocean, USA	Canada	Pacific Ocean, Fiji	n/a	Vietnam
Fish 1	32 in, 15 lbs	25 in, 4.3 lbs	n/a	n/a	47 in, 90 lbs
Fish 2	33 in, 17 lbs	26 in, 5 lbs	n/a	n/a	46 in, 81 lbs
Fish 3	31.7 in, 14 lbs	24 in, 4.8 lbs	n/a	n/a	51 in, 146 lbs
Moisture (%)	62.3 ± 0.18	64.21 ± 0.36	69.43 ± 0.14	48.89 ± 0.59	72.1 ± 0.33
Total Fat (%)	12.33 ± 0.35	9.50 ± 0.51	1.75 ± 0.07	28.21 ± 0.92	1.45 ± 0.20
Mercury (ppb)	426.83 ± 15.31	230.95 ± 10.38	313.96 ± 15.11	727.30 ± 60.00	149.97 ± 5.51
FA (mg/100 g)					
12:0	5.9 ± 0.5	3.4 ± 0.3	-	12.3 ± 0.8	-
14:0	421.1 ± 34.1	253.1 ± 17.8	38.7 ± 1.2	1656.7 ± 12.4	14.8 ± 1.1
16:0	2205.1 ± 178.9	1717.8 ± 108.1	378.4 ± 7.1	4348.1 ± 58.2	177.8 ± 10.6
18:0	719.9 ± 59.8	504.3 ± 27.6	106 ± 0.9	1019 ± 22.9	72.8 ± 5.1
20:0	23.3 ± 1.9	15.7 ± 0.6	4.3 ± 0	74.9 ± 2.1	3.2 ± 0.2
22:0	14.4 ± 1.3	9.9 ± 0.6	3.2 ± 0.1	-	2.6 ± 0.1
24:0	-	5.1 ± 5.8	3.3 ± 0.1	-	2.9 ± 0.2
Σ SFA	3389.7	2509.5	533.9	7110.9	274.0
14:1n5	3.6 ± 0.5	3.4 ± 0.3	-	40.5 ± 33.3	-
16:1n7	487.7 ± 34.7	304.2 ± 19.2	70.6 ± 1.1	1631.5 ± 20.6	34.3 ± 1.1
18:1n7	391.7 ± 29	204.9 ± 12.6	41.2 ± 0.3	629.6 ± 2.2	21.8 ± 1.2
18:1n9	1803.8 ± 128.7	1246.5 ± 64.5	221.9 ± 1.9	3894.8 ± 72.7	116.2 ± 6.4
20:1n9	182.1 ± 14.2	131.9 ± 10.8	13.8 ± 0.1	2516.7 ± 49	5.8 ± 0.5
22:1n9	41 ± 3.9	22.6 ± 1.8	2.1 ± 0.2	32.2 ± 2.8	-
24:1n9	14.9 ± 0.8	43.1 ± 45.8	8.6 ± 0.1	13 ± 6.6	6.1 ± 0.4
Σ MUFA	2924.7	1956.5	358.2	8758.4	184.2
16:2n4	27.4 ± 2.3	12.8 ± 0.7	3.2 ± 0.1	114.8 ± 6	1 ± 0
16:3n4	14 ± 1.5	2.5 ± 0.2	1.3 ± 0.1	82.7 ± 2.7	-
LA	158.1 ± 10.9	109.7 ± 6.5	13.2 ± 0.1	515 ± 2.5	7.1 ± 0.2
ALA	89.5 ± 6.4	59.6 ± 3	4.5 ± 0	317.3 ± 1.9	2.1 ± 0.1
18:3n4	24.3 ± 0.8	18.1 ± 0.6	4.1 ± 0.1	51.4 ± 1.2	2.2 ± 0.2
18:3n6	17.6 ± 0.9	12.9 ± 0.7	1.6 ± 0	47.2 ± 1.2	-
SDA	191.3 ± 13	133 ± 6.8	5.1 ± 0	674.8 ± 7.1	2 ± 0.1
20:2n6	29.4 ± 2.3	26.4 ± 2	3.7 ± 0	72.4 ± 0.7	1.7 ± 0.1
20:3n3	17.8 ± 1.1	20 ± 1.8	2.8 ± 0.1	46.2 ± 0.6	-
20:3n6	13.7 ± 0.9	6.2 ± 0	1.6 ± 0.1	24.3 ± 0.7	1.1 ± 0.1
20:4n3	77 ± 5.7	52.6 ± 2	4.5 ± 0	191.3 ± 3.5	2 ± 0
ARA	141.2 ± 9.9	77.6 ± 2.9	35.3 ± 0.2	193.1 ± 3.1	30.1 ± 1.2
EPA	1150.6 ± 77.4	724.9 ± 23.2	62.5 ± 0.4	2097.4 ± 35.7	26.1 ± 0.6
22:2n6	2.6 ± 0.1	1.9 ± 0.2	-	8.4 ± 0.4	-
22:4n6	15.6 ± 1.7	8.1 ± 0.3	6.5 ± 2.7	27.7 ± 3.6	4.6 ± 0.1
DPAn-3	209.9 ± 14	97.3 ± 2.2	16.5 ± 0	368.4 ± 9.1	11.5 ± 0.2
DHA	2427.2 ± 162.6	2229.8 ± 29.9	315.4 ± 1.3	3526.1 ± 51.8	152 ± 6.7
Σ (n-3) FA	4163.4	3317.2	411.1	7221.4	195.7
Σ (n-6) FA	378.2	242.8	61.8	888.2	44.6
Σ PUFA	4607.3	3593.4	481.5	8358.4	243.6
mg EPA + DHA in 8 oz	8114.4	6701.2	856.9	12753.7	403.8
oz to 1750 mg EPA + DHA	1.73	2.09	16.34	1.10	34.71

Common name	Tuna, Yellowfin				
Latin name	*Thunnus albacares*				
Vendor Date Farm/Wild	NE3 Oct 2012 Wild	NE4 May 2013 Wild	SE1 Sept 2012 Wild	SE1 May 2013 Wild	SE2 June 2013 Wild
Location	Vietnam	Carribean Sea, Grenada	South Atlantic Ocean, Grenada	Gulf of Mexico, USA	Brazil
Fish 1	105 in	41.5 in, 99 lbs	*60 lbs	n/a	40 in, 104 lbs
Fish 2	105 in	40 in, 69 lbs	*60 lbs	n/a	48 in, 176 lbs
Fish 3	105 in	45 in, 110 lbs	*60 lbs	n/a	41 in, 109 lbs
Moisture (%)	73.35 ± 0.19	72.7 ± 0.06	72.75 ± 0.15	74.12 ± 0.04	72.62 ± 0.25
Total Fat (%)	0.54 ± 0.04	0.76 ± 0.00	1.68 ± 0.04	0.53 ± 0.02	0.92 ± 0.02
Mercury (ppb)	108.34 ± 2.93	293.69 ± 3.73	604.12 ± 9.33	429.73 ± 25.14	240.33 ± 6.05
FA (mg/100 g)					
12:0	-	-	-	-	-
14:0	2.2 ± 0.4	1.6 ± 0	35.7 ± 1.2	2.2 ± 0.3	4.4 ± 0.6
16:0	84.9 ± 3.3	59 ± 0.6	279.3 ± 2.9	58.1 ± 1.6	109.4 ± 8.5
18:0	36.4 ± 0.8	35.7 ± 0.4	98.6 ± 2.9	33 ± 1.3	55.5 ± 3.4
20:0	-	-	4.4 ± 0.2	-	2.2 ± 0.1
22:0	-	-	2.4 ± 0.1	-	1.7 ± 0.1
24:0	-	-	2.5 ± 0	-	2.3 ± 0.1
Σ SFA	123.5	96.2	422.9	93.2	175.6
14:1n5	-	-	-	-	-
16:1n7	4.7 ± 1.1	4.8 ± 0.1	57.8 ± 0.5	4.8 ± 0.6	10.5 ± 1.2
18:1n7	5.3 ± 0.5	6.3 ± 0.1	33.7 ± 1	4.9 ± 0.4	11.1 ± 0.9
18:1n9	41.3 ± 6.6	39.8 ± 1.1	194.5 ± 6.1	36.8 ± 3.8	77.3 ± 6.1
20:1n9	2.2 ± 0.1	2 ± 0.1	29.1 ± 1.4	1.9 ± 0.9	4.1 ± 0.3
22:1n9	-	-	4.3 ± 0	-	-
24:1n9	2.6 ± 0.3	3.2 ± 0.3	9 ± 2.1	2.6 ± 0.4	5.4 ± 0.3
Σ MUFA	56.2	56.1	328.4	51.0	108.3
16:2n4	2.1 ± 0.3	2.3 ± 0.1	2.4 ± 0	-	-
16:3n4	1.4 ± 0	1.5 ± 0	1.5 ± 0.1	-	-
LA	4.5 ± 2.7	3.1 ± 0	14.2 ± 0.5	2.6 ± 0.2	5.1 ± 0.5
ALA	-	-	6.1 ± 0	-	-
18:3n4	-	-	3.2 ± 0.2	-	1.3 ± 0.1
18:3n6	-	-	1.7 ± 0.1	-	-
SDA	-	-	7.3 ± 0	-	-
20:2n6	-	-	4.8 ± 0.2	-	1.4 ± 0.1
20:3n3	-	-	3.6 ± 0.2	-	-
20:3n6	-	-	1.9 ± 0.1	-	-
20:4n3	-	-	5.3 ± 0.3	-	1.2 ± 0.1
ARA	18.9 ± 1.9	16.6 ± 0.5	32 ± 1.1	15.4 ± 1.3	27 ± 1
EPA	11 ± 2.5	8.6 ± 0.1	87 ± 3.3	7.3 ± 0.2	15.7 ± 0.9
22:2n6	-	-	-	-	-
22:4n6	2 ± 0.3	1.8 ± 0	4 ± 0.4	1.3 ± 0.1	3.5 ± 0.1
DPAn-3	3.3 ± 0.9	3.3 ± 0	21.2 ± 0.6	3.3 ± 0.5	7.3 ± 0.3
DHA	87.9 ± 18.3	73.4 ± 2.4	289.1 ± 11	58.6 ± 5	150.3 ± 4.2
Σ (n-3) FA	102.2	85.3	419.6	69.1	174.6
Σ (n-6) FA	25.3	21.5	58.5	19.3	37.0
Σ PUFA	131.0	110.6	485.2	88.5	212.9
mg EPA + DHA in 8 oz	224.4	186.0	853.0	149.5	376.7
oz to 1750 mg EPA + DHA	63.79	75.33	16.42	93.99	37.19

Common name	Wahoo		Walleye		
Latin name	*Acanthocybium solandri*		*Sander vitreus*		
Vendor Date Farm/Wild	SW1 Aug 2012 Wild	SW1 Apr 2013 Wild	GL1 Oct 2010 Wild	GL1 Oct 2012 Wild	GL3^ July 2013^ Wild^
Location	New Zealand	Pacific Ocean, USA	Lake Erie, Canada	Lake Erie	Lake Superior, USA^
Fish 1	n/a	40 in, 35.9 lbs	17.2 in, 3.9 lbs	14.75 in, 1.98 lbs	n/a^
Fish 2	*40 in	35 in, 32.5 lbs	16.5 in, 3.3 lbs	15 in, 1.94 lbs	
Fish 3	*42 in	35.5 in, 34.8 lbs	17 in, 3.7 lbs	15.75 in, 2.12 lbs	
Moisture (%)	75.82 ± 0.23	72.96 ± 0.4	78.26 ± 0.12	80.74 ± 0.10	n/a
Total Fat (%)	1.55 ± 0.27	2.67 ± 0.08	2.73 ± 0.04	1.37 ± 0.08	
Mercury (ppb)	166.95 ± 1.37	686.62 ± 30.14	190.81 ± 11.39	109.45 ± 3.90	(see below)
FA (mg/100 g)					
12:0	-	-	-	-	444.11 ± 33.05^
14:0	10.7 ± 0.3	40.1 ± 2.4	78 ± 5.4	5.4 ± 0.1	407.45 ± 8.24^
16:0	208.4 ± 1.4	668.2 ± 19.7	360.7 ± 13.9	91.1 ± 1.6	383.23 ± 24.67^
18:0	62.3 ± 0.4	181.3 ± 3.3	49.9 ± 0.4	17.4 ± 0.6	350.50 ± 28.37^
20:0	2.1 ± 0.1	9.2 ± 0.3	1.6 ± 0.1	-	258.39 ± 11.95^
22:0	1.6 ± 0	4.6 ± 0.2	-	-	318.02 ± 7.11^
24:0	1.6 ± 0	4.1 ± 0.1	1.3 ± 0	-	280.45 ± 13.17^
Σ SFA	286.6	907.5	491.4	113.9	409.44 ± 35.00^
14:1n5	-	-	7.2 ± 0.6	-	266.47 ± 9.01^
16:1n7	22.8 ± 1.1	113.6 ± 3.1	270.5 ± 19.5	24.4 ± 0.8	423.97 ± 20.10^
18:1n7	18.1 ± 0.4	69.4 ± 1.5	82.7 ± 3.6	12.4 ± 0.4	418.77 ± 21.20^
18:1n9	115.2 ± 2.4	540.1 ± 13	474.8 ± 27.8	34.9 ± 1.3	424.54 ± 17.33^
20:1n9	6.4 ± 0.2	34.9 ± 0.9	6.5 ± 0.4	-	451.73 ± 18.39^
22:1n9	-	4.5 ± 0.4	1.4 ± 0.4	-	588.04 ± 44.10^
24:1n9	6.2 ± 0.5	15.7 ± 0.7	5.3 ± 0.7	2 ± 0	726.42 ± 28.82^
Σ MUFA	168.7	778.3	848.3	73.7	465.76 ± 12.72^
16:2n4	-	2.3 ± 0.2	13.6 ± 1.1	1.9 ± 0.1	443.98 ± 11.66^
16:3n4	-	17.1 ± 0.7	5.9 ± 0.7	-	454.06 ± 16.64^
LA	6.4 ± 0	20.6 ± 0.3	96.9 ± 5.5	6.4 ± 0.3	
ALA	-	5.3 ± 0.3	84.7 ± 5.5	7.9 ± 0.3	
18:3n4	2.2 ± 0.5	5.7 ± 0.1	3.6 ± 0.5	-	^18 samples of walleye tested individually for mercury; values given are for mercury
18:3n6	-	1.7 ± 0.1	5.1 ± 0.4	-	
SDA	2.1 ± 0	6 ± 0.3	33.3 ± 2.1	3.4 ± 0.1	
20:2n6	1.7 ± 0	6 ± 0.2	4.8 ± 0.1	-	
20:3n3	-	3.6 ± 0.1	4.7 ± 0.3	-	
20:3n6	-	2.4 ± 0.1	3.7 ± 0.2	-	
20:4n3	2.1 ± 0	7.6 ± 0.3	14.5 ± 0.7	3.1 ± 0.2	
ARA	21.1 ± 0.8	50.5 ± 0.8	101.6 ± 1.6	27.2 ± 1.1	
EPA	25.2 ± 0.3	64.8 ± 1.8	174.6 ± 7.7	42.8 ± 1.7	
22:2n6	-	-	-	-	
22:4n6	3.3 ± 0.1	11.5 ± 0.5	11.3 ± 2.3	4.6 ± 0.3	
DPAn-3	10.1 ± 0.1	40.4 ± 0.6	47.7 ± 0.7	13 ± 0.3	
DHA	214.7 ± 8.5	497.6 ± 3.2	282.5 ± 7.2	90.3 ± 2	
Σ (n-3) FA	254.3	625.4	642.0	160.4	
Σ (n-6) FA	32.5	92.6	223.4	38.2	
Σ PUFA	289.0	743.1	888.6	200.5	
mg EPA + DHA in 8 oz	544.3	1275.7	1036.7	302.0	-
oz to 1750 mg EPA + DHA	25.74	10.98	13.51	46.39	-

Common name *Latin name*	Whitefish, Lake *Coregonus clupeaformis*			
Vendor Date Farm/Wild	GL1 Oct 2010 Wild	GL1 Oct 2012 Wild	GL3 July 2013 Wild	GL3 July 2013 Wild
Location	Lake Superior, USA	Lake Superior	Lake Superior, USA	Lake Superior, USA
Fish 1	18 in, 2.75 lbs	16.5 in, 1.94 lbs	n/a	n/a
Fish 2	18 in, 2.95 lbs	16.5 in, 2.16 lbs	n/a	n/a
Fish 3	18 in, 3.1 lbs	17.5 in, 2.64 lbs	n/a	n/a
Moisture (%)	75.81 ± 0.06	75.01 ± 0.65	75.23 ± 0.16	75.01 ± 0.43
Total Fat (%)	3.91 ± 0.16	4.82 ± 0.24	3.75 ± 0.08	4.68 ± 0.09
Mercury (ppb)	90.47 ± 1.95	46.99 ± 1.50	59.99 ± 5.46	88.74 ± 4.51
FA (mg/100 g)				
12:0	2.5 ± 0	3.9 ± 0.2	6.6 ± 0.3	8.1 ± 0.8
14:0	77.9 ± 1	118.8 ± 4.3	105.8 ± 5.5	163.1 ± 13.7
16:0	483.4 ± 2.6	703.1 ± 33.2	485.1 ± 21.1	692.6 ± 49
18:0	99.1 ± 0.1	146.3 ± 7.3	89.6 ± 4.2	95.2 ± 4.8
20:0	2.9 ± 0.1	5 ± 0.4	3.4 ± 0.1	3.6 ± 0.2
22:0	1.5 ± 0	3.1 ± 0.3	2.8 ± 0.3	2.3 ± 0
24:0	1.2 ± 0	2.2 ± 0	2.7 ± 0.1	1.4 ± 0
Σ SFA	668.5	982.4	695.9	966.3
14:1n5	3.6 ± 0.9	3.7 ± 0.2	4.1 ± 0.1	5 ± 0.5
16:1n7	310.7 ± 5.6	329.5 ± 17.8	374.2 ± 17	592.4 ± 54.5
18:1n7	137 ± 1.9	182.5 ± 17.5	177.1 ± 8.5	186 ± 11.7
18:1n9	570 ± 8.8	764.4 ± 25.3	537.5 ± 21.2	883 ± 62.5
20:1n9	28.8 ± 1	33.1 ± 2.7	29.7 ± 0.9	48.1 ± 3
22:1n9	6.2 ± 0.1	7.1 ± 0.3	6.8 ± 0.3	10 ± 1
24:1n9	7.5 ± 0.2	5.2 ± 0.2	8 ± 0.5	10.1 ± 0.2
Σ MUFA	1063.8	1325.5	1137.5	1734.7
16:2n4	16.1 ± 0.3	18.1 ± 0.2	20.3 ± 0.6	31.4 ± 2.8
16:3n4	8.6 ± 0.2	6.8 ± 0.2	10.5 ± 0.6	16.9 ± 1.5
LA	88.9 ± 1.5	129 ± 5.3	102.8 ± 4	176.4 ± 11.5
ALA	71.3 ± 1.1	113.4 ± 5.1	66.7 ± 2.9	131.3 ± 7.9
18:3n4	8.2 ± 0.1	8 ± 0.4	11.2 ± 0.2	9.4 ± 0.5
18:3n6	8.1 ± 0.2	11.1 ± 0.3	8.9 ± 0	14.4 ± 1
SDA	38.8 ± 0.6	62.4 ± 1	44.6 ± 1.4	101.5 ± 6.9
20:2n6	16.1 ± 0.2	17 ± 1.1	26.5 ± 1	32.2 ± 1.9
20:3n3	11 ± 0.2	16.8 ± 1.8	13.4 ± 0.6	22.1 ± 1.3
20:3n6	9.3 ± 0.1	8.9 ± 0.4	12.8 ± 0.5	12.4 ± 0.4
20:4n3	31 ± 0.9	41.8 ± 3	38.5 ± 1.1	64.7 ± 2.6
ARA	115.4 ± 1	151 ± 7.7	95.9 ± 4.2	110.9 ± 4.1
EPA	201.1 ± 3	312.5 ± 14.9	220.9 ± 9.2	287.4 ± 16
22:2n6	2.4 ± 0	2.7 ± 0.2	3.8 ± 0.1	4.6 ± 0.5
22:4n6	28.4 ± 0.6	27.6 ± 3.7	27.3 ± 1.1	24 ± 1.5
DPAn-3	91.9 ± 1.6	95 ± 5.6	88.7 ± 3.7	99.4 ± 2.8
DHA	343.3 ± 1.8	248 ± 2.6	313.6 ± 11.6	438.9 ± 17.5
Σ (n-3) FA	788.5	889.9	786.3	1145.4
Σ (n-6) FA	268.5	347.1	278.0	374.8
Σ PUFA	1089.9	1269.9	1106.2	1578.0
mg EPA + DHA in 8 oz	1234.8	1271.2	1212.2	1647.3
oz to 1750 mg EPA + DHA	11.34	11.02	11.56	8.51

Common name *Latin name*	Whitefish, Lake *Coregonus clupeaformis*		Whiting, Pacific *Merluccius productus*	
Vendor Date Farm/Wild	GL3 July 2013 Wild	GL3 July 2013 Wild	NW1 Sept 2012 Wild	NW1 Mar 2013 Wild
Location	Lake Superior, USA	Lake Superior, USA	Pacific Ocean, USA	Pacific Ocean, USA
Fish 1	n/a	n/a	n/a	*10 in, *<1 lb
Fish 2	n/a	n/a	n/a	*10 in, *<1 lb
Fish 3	n/a	n/a	n/a	*10 in, *<1 lb
Moisture (%)	75.65 ± 0.10	75.67 ± 0.35	83.02 ± 0.55	81.76 ± 0.24
Total Fat (%)	5.37 ± 0.39	4.04 ± 0.28	1.53 ± 0.19	1.63 ± 0.33
Mercury (ppb)	51.75 ± 2.03	69.13 ± 1.18	19.45 ± 0.61	16.12 ± 0.11
FA (mg/100 g)				
12:0	8.9 ± 0.9	7.4 ± 0.5	-	-
14:0	193.5 ± 15.8	145.6 ± 9.1	31.9 ± 3.3	40.9 ± 4.3
16:0	810.3 ± 60.4	657.2 ± 44	276.6 ± 12.7	255.9 ± 25.8
18:0	105 ± 7.3	93.3 ± 6.3	42.3 ± 0.1	41 ± 1.8
20:0	4.2 ± 0.6	3.5 ± 0.2	-	-
22:0	2.8 ± 0.3	2.3 ± 0.2	-	-
24:0	1.6 ± 0.2	1.6 ± 0.1	-	-
Σ SFA	1126.2	910.8	350.7	337.8
14:1n5	5.5 ± 0.5	4 ± 0.1	-	-
16:1n7	646.4 ± 63.7	496.6 ± 38.6	67.8 ± 4.6	66.2 ± 9.6
18:1n7	191.4 ± 13.5	153.8 ± 9.4	65.3 ± 3.2	67.2 ± 4.6
18:1n9	957.8 ± 73.2	709.2 ± 49.7	175.9 ± 1.3	138.1 ± 25.4
20:1n9	46.4 ± 4.9	39.1 ± 2.9	9.7 ± 0.4	9.3 ± 2.3
22:1n9	10.7 ± 0.8	8.5 ± 0.3	1.8 ± 0.9	2.1 ± 0.6
24:1n9	12.5 ± 1.1	9.8 ± 0.6	5.5 ± 0.2	5.7 ± 0.7
Σ MUFA	1870.8	1421.0	325.9	288.5
16:2n4	34.6 ± 4	27.7 ± 2.4	8.5 ± 0.8	9.3 ± 0.4
16:3n4	17.1 ± 1.8	14.8 ± 0.8	3.9 ± 0.2	3.5 ± 0.2
LA	202.8 ± 17.9	151.9 ± 9.9	13.2 ± 0.3	16.9 ± 1.7
ALA	152.7 ± 12.2	112.4 ± 6.2	6 ± 0.5	10.6 ± 0.8
18:3n4	10.6 ± 1	9 ± 0.4	1.3 ± 0.1	1.1 ± 0.2
18:3n6	17.5 ± 1.8	13.4 ± 1.1	1.2 ± 0.1	1.3 ± 0.1
SDA	127.2 ± 9.4	86 ± 4.8	13 ± 1	20 ± 0.8
20:2n6	37.3 ± 3.5	28.1 ± 1.8	1.7 ± 0	2 ± 0.2
20:3n3	31.2 ± 2	19.9 ± 1.2	-	1.6 ± 0.1
20:3n6	17.1 ± 1.4	11.9 ± 0.8	-	1 ± 0
20:4n3	100.1 ± 6.7	62.5 ± 3.9	5 ± 0.2	6.1 ± 0.3
ARA	132 ± 7.2	103.1 ± 4.9	11.9 ± 0.1	14.9 ± 0.4
EPA	369.3 ± 26.9	271.3 ± 16.8	178.2 ± 2.1	207.9 ± 2.3
22:2n6	6.1 ± 0.6	4.4 ± 0.3	-	-
22:4n6	26.8 ± 1.8	22.6 ± 0.8	-	-
DPAn-3	129.5 ± 8.2	96 ± 4.8	10.6 ± 0.2	12.3 ± 0.5
DHA	544.7 ± 36.1	434.8 ± 31.8	175.3 ± 9.8	217.1 ± 3
Σ (n-3) FA	1454.7	1082.9	388.2	475.6
Σ (n-6) FA	439.5	335.4	28.0	36.1
Σ PUFA	1956.6	1469.8	429.9	525.5
mg EPA + DHA in 8 oz	2073.0	1601.4	801.9	963.9
oz to 1750 mg EPA + DHA	6.77	8.77	17.47	14.53