An Assessment of Fish Tissue Pollutants in Arizona Lakes

By Jason Jones and Sam Rector

ADEQ
Arizona Department of Environmental Quality

INTRODUCTION

Purpose

This study is the first systematic assessment of mercury, polychlorinated biphenyls (PCBs) and selenium in wild caught consumable fish in Arizona's lakes. The study will outline the prevalence of these contaminants in Arizona's lakes and will provide guidance for how to eat fish responsibly. Lakes were chosen using a probabilistic or random sampling design which allows statistical inferences to be made about fish tissue in all the states lakes.

The Arizona Department of Environmental Quality (ADEQ) prepared this report for the U.S Environmental Protection Agency (EPA) as directed in the state fiscal year 2021 and 2022 work plan. Conducting state scale probabilistic assessments is a monitoring initiative in Arizona's Comprehensive Water Quality Monitoring Strategy (ADEQ, 2020).

Fish are Part of a Healthy Diet

Fish are an important part of a healthy diet because they are a lean, low calorie source of protein. Fish have omega-3 polysaturated fatty acids which are beneficial to our overall health. The Arizona Department of Health Services estimates that approximately 451,980 Arizonans ate at least one fish meal per year from lakes and streams in Arizona (ADHS, 2009).

Poor diets contribute to obesity which is estimated to kill 280,134 Americans a year (Allison, 1999). The rate of obesity has increased dramatically in the United States over the last 50 years. In 1960, 14 percent of American's had a body mass index in the obese range (> 30). Today roughly 40 percent of the population is obese (CDC, 2020).

There is risk inherent in any food you eat. The USDA's 2015-2020 dietary guidelines recommend that Americans eat at least eight ounces (less for young children) of seafood/fish per week. The Environmental Protection Agency and Food and Drug Administration suggests eating fish that are lower in mercury (Figure 1).

This chart can help you choose which fish to eat, and how often to eat them, based on their mercury levels.

What is a serving? As a guide, use the palm of your hand.

For an adult
1 serving = 4 ounces
Eat 2 to 3 servings a week from the "Best Choices" list (**OR** 1 serving from the "Good Choices" list).

For children, a serving is 1 ounce at age 2 and increases with age to 4 ounces by age 11.

If you eat fish caught by family or friends, check for fish advisories. If there is no advisory, eat only one serving and no other fish that week.*

Best Choices
EAT 2 TO 3 SERVINGS A WEEK

Anchovy
Atlantic croaker
Atlantic mackerel
Black sea bass
Butterfish
Catfish
Clam
Cod
Crab
Crawfish
Flounder
Haddock
Hake
Herring
Lobster, American and spiny
Mullet
Oyster
Pacific chub mackerel
Perch, freshwater and ocean
Pickerel
Plaice
Pollock
Salmon
Sardine
Scallop
Shad
Shrimp
Skate
Smelt
Sole
Squid
Tilapia
Trout, freshwater
Tuna, canned light (includes skipjack)
Whitefish
Whiting

OR

Good Choices
EAT 1 SERVING A WEEK

Bluefish
Buffalofish
Carp
Chilean sea bass/ Patagonian toothfish
Grouper
Halibut
Mahi mahi/ dolphinfish
Monkfish
Rockfish
Sablefish
Sheepshead
Snapper
Spanish mackerel
Striped bass (ocean)
Tilefish (Atlantic Ocean)
Tuna, albacore/ white tuna, canned and fresh/frozen
Tuna, yellowfin
Weakfish/ seatrout
White croaker/ Pacific croaker

Choices to Avoid
HIGHEST MERCURY LEVELS

King mackerel
Marlin
Orange roughy
Shark
Swordfish
Tilefish (Gulf of Mexico)
Tuna, bigeye

* Some fish caught by family and friends, such as larger carp, catfish, trout and perch, are more likely to have fish advisories due to mercury or other contaminants. State advisories will tell you how often you can safely eat those fish.

www.FDA.gov/fishadvice
www.EPA.gov/fishadvice

EPA United States Environmental Protection Agency
FDA U.S. FOOD & DRUG ADMINISTRATION

Figure 1. Fish consumption advice. See the conclusion section for advice on Arizona fish consumption rates.

Arizona's Fish Consumption Advisory Program

ADEQ monitors contaminants in fish tissues statewide, prioritizing waterbodies that are popular fishing spots. When ADEQ's tests show a fish species in a stream or lake has a contaminant level higher than health standards, ADEQ issues a fish consumption advisory that identifies the contaminant of concern and provides guidance for which fish to eat and how much. There are currently 29 waterbodies with a fish advisory (Figure 3 and Table 1). Twenty-two advisories are on lakes and six are for streams. All advisories are currently for mercury. Waterbodies that have a fish advisory are placed on Clean Water Act section 303(d) impaired waters list.

The public is notified of fish advisories through signs and press releases (Figure 2). Advisories are color coded. **Red** advisories mean do not eat the fish species in this lake. **Orange** advisories mean adults should limit consumption to 2.5 ounces (uncooked weight) per week and children 12 years of age and younger limit consumption to two ounces per month (uncooked weight). **Green** advisories mean that the advice in Figure 1 may be followed.

Figure 2. Fish advisory sign at Horse Thief Basin.

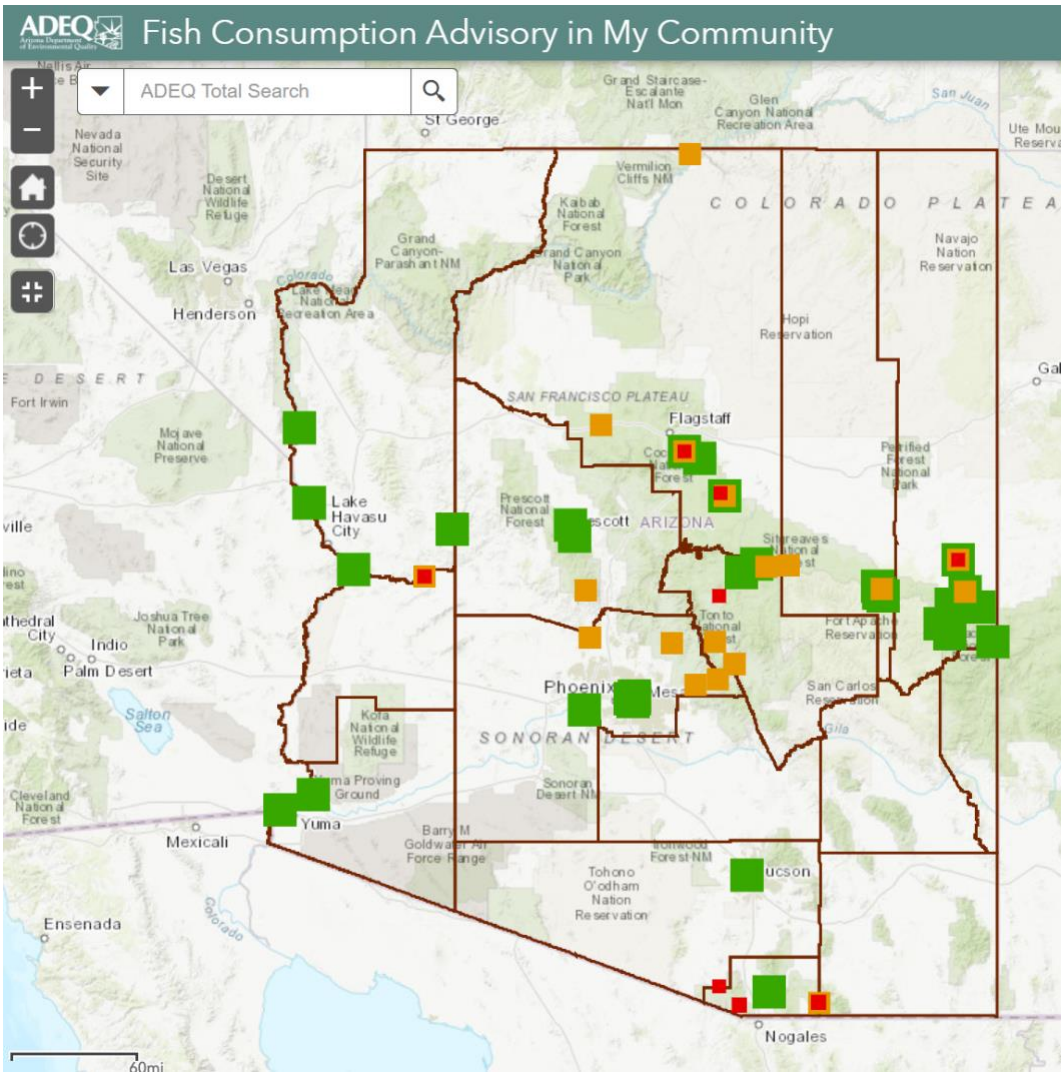

Figure 3. Arizona Fish Advisories. A map of current fish advisories is available at https://adeq.maps.arcgis.com/

Table 1. List of Arizona Fish Advisories. A current fish advisories are available at https://www.azgfd.com/fishing/fishconsumption/.

Waterbody Name	Waterbody ID	Species	Parameter	Advice
Alamo Lake	15030204-0040A	Black crappie	Mercury	**Do not eat**
Alamo Lake	15030204-0040A	Largemouth bass	Mercury	**Do not eat**
Arivaca Lake	15050304-0080	Largemouth bass	Mercury	**Do not eat**
Lake Mary (lower)	15020015-0890	Walleye	Mercury	**Do not eat**
Lake Mary (upper)	15020015-0900	Walleye	Mercury	**Do not eat**
Parker Canyon Lake	15050301-1040	Largemouth bass	Mercury	**Do not eat**
Peña Blanca Lake	15050301-1070	Largemouth bass	Mercury	**Do not eat**
Soldier Lake	15020008-1440	Walleye	Mercury	**Do not eat**
Soldier Annex	15020008-1430	Walleye	Mercury	**Do not eat**
Tonto Creek	15060105-004	Smallmouth bass	Mercury	**Do not eat**
Tonto Creek	15060105-006	Smallmouth bass	Mercury	**Do not eat**
Tonto Creek	15060105-008	Smallmouth bass	Mercury	**Do not eat**
Tonto Creek	15060105-009	Smallmouth bass	Mercury	**Do not eat**
Tonto Creek	15060105-011	Smallmouth bass	Mercury	**Do not eat**
Tonto Creek	15060105-013A	Smallmouth bass	Mercury	**Do not eat**
Tonto Creek	15060105-013B	Smallmouth bass	Mercury	**Do not eat**
Lyman Reservoir	15020001-0850	Walleye	Mercury	**Do not eat**
Lake Powell	14070006-1130	Striped bass	Mercury	**Joint Advisory with Utah**
Tonto Creek	15060105-004	Common Carp	Mercury	**Limit Consumption**
Tonto Creek	15060105-006	Common Carp	Mercury	**Limit Consumption**
Tonto Creek	15060105-008	Common Carp	Mercury	**Limit Consumption**
Tonto Creek	15060105-009	Common Carp	Mercury	**Limit Consumption**
Tonto Creek	15060105-011	Common Carp	Mercury	**Limit Consumption**
Tonto Creek	15060105-013A	Common Carp	Mercury	**Limit Consumption**
Tonto Creek	15060105-013B	Common Carp	Mercury	**Limit Consumption**
Becker Lake	15020001-0150	Largemouth bass	Mercury	**Limit Consumption**
Black Canyon Reservoir	15020010-0180	Largemouth bass	Mercury	**Limit Consumption**
Canyon Lake	15060106A-0250	Yellow bass	Mercury	**Limit Consumption**
Horsethief Basin Lake	15070102-0630	Largemouth bass	Mercury	**Limit Consumption**
Santa Fe Lake	15010004-1340	Black crappie	Mercury	**Limit Consumption**
Willow Springs Reservoir	15020010-1670	Largemouth bass	Mercury	**Limit Consumption**
Alamo Lake	15030204-0040A	Channel catfish	Mercury	**Limit Consumption**
Apache Lake	15060106A-0070	Largemouth bass	Mercury	**Limit Consumption**
Bartlett Lake	15060203-0110	Channel catfish	Mercury	**Limit Consumption**
Bartlett Lake	15060203-0110	Largemouth bass	Mercury	**Limit Consumption**
Bartlett Lake	15060203-0110	Flathead Catfish	Mercury	**Limit Consumption**
Lake Mary (lower)	15020015-0890	Northern pike	Mercury	**Limit Consumption**
Lake Mary (upper)	15020015-0900	Northern pike	Mercury	**Limit Consumption**
Lake Pleasant	15070102-1100	Largemouth bass	Mercury	**Limit Consumption**

Waterbody Name	Waterbody ID	Species	Parameter	Advice
Lake Pleasant	15070102-1100	Striped bass	Mercury	**Limit Consumption**
Long Lake (lower)	15020008-0820	Walleye	Mercury	**Limit Consumption**
Lyman Reservoir	15020001-0850	Channel catfish	Mercury	**Limit Consumption**
Parker Canyon Lake	15050301-1040	Bluegill	Mercury	**Limit Consumption**
Peña Blanca Lake	15050301-1070	Black crappie	Mercury	**Limit Consumption**
Roosevelt Lake	15060103-1240	Channel catfish	Mercury	**Limit Consumption**
Roosevelt Lake	15060103-1240	Largemouth bass	Mercury	**Limit Consumption**
Scott Reservoir	15020005-1360	Largemouth bass	Mercury	**Limit Consumption**

Background on Mercury, Polychlorinated Biphenyls and Selenium

Mercury and PCBs are by far the most common pollutants in fish tissue. EPA survived 76,559 lakes throughout the United States and found that 48% of lakes exceeded the human health threshold for mercury and 16.8% of lakes exceeded for PCBs (EPA, 2009).

Mercury

Mercury is a neurotoxin that bioaccumulates in the higher trophic states of the food chain. ADEQ issued the first mercury fish advisory in 1995 for Pena Blanca Lake. In the United States, primary sources of mercury emissions include coal-burning power plants, hazardous waste incineration, chlorine production, and mercury product breakage and spillage (USEPA 2009). Arizona's mercury in fish tissue standard of 0.3 mg/kg became effective in 2009 (AZSOS, 2020).

Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs) are a group of human-made chlorinated organic compounds and were once widely used in plasticizers, carbonless copy paper, lubricants, electronic capacitors and in electrical distribution networks as coolant fluid in transformers. The manufacture of PCBs began in the United States in 1929 and continued until commercial production and importation ceased in 1977. The use of PCBs was banned by the United States in 1979 and in Europe in 1987.

PCBs are produced by the substitution of chlorine atoms for one or more of the hydrogen atoms in the structure of biphenyl ($C_{12}H_{10}$). Biphenyl consists of two benzene rings connected by a single carbon bond. Each individual biphenyl molecule and associated chlorine molecules is a congener (Figure 4). The symmetry of the biphenyl molecule limits the different combinations to 209 individual congeners that can be broken down into two groups according to the structure of the molecule.

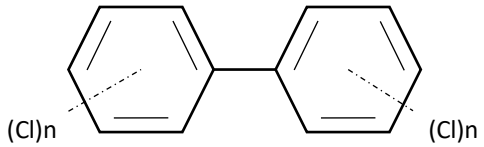

Figure 4. Chemical structure of PCBs. The possible positions of chlorine atoms on the benzene rings are denoted by numbers assigned to the carbon atoms.

Commercially, PCBs were produced and marketed in the United States under the trade name Aroclor by the Monsanto Corporation. Some of the properties of PCBs that made them commercially valuable, their chemical and heat stability, also made them problematic once released into the environment. PCBs are extremely stable. Abiotic processes such as oxidation and hydrolysis do not significantly degrade them (EPA, 1979) and photodegradation varies with the degree of chlorination.

Selenium

Selenium is an element that occurs naturally in many areas and is produced through industrial processes. It is an essential nutrient with a recommended dietary allowance of 55 µg/d (0.055 mg) for adult men and women (EPA, 1999). Selenium is the fifth most common impairment in Arizona (ADEQ, 2016). All impairments for selenium are for the aquatic and wildlife designated use. There are currently no impairments for the fish consumption designated use.

METHODS

Lakes were chosen from Arizona Game and Fish's list of where to fish in Arizona (https://www.azgfd.com/fishing/locations/). Streams, canals, and sites (landings, coves and beaches) already included in a larger waterbody were excluded. A random number generator was used in Excel to randomly assign each of the 100 lakes with an identifying number. Each waterbody underwent a desktop evaluation for sampling access management changes and seasonal water fluctuations. Sampling locations were removed if they were deemed inaccessible, or unsamplable for other reasons such the boat ramp is above the water level. Sites that were removed were replaced with the next site on the randomized list (Appendix A).

Fish samples were taken By Arizona Department of Environmental Quality (ADEQ) and Arizona Game and Fish Department (AGFD) personnel, either using a boat-mounted electroshocker or by setting passive gill nets. A goal of five sportfish of the same species and of similar size was set, with less than 5, but more than three fish. Mixed species samples were considered adequate if the goal could not be reasonably met. Species from higher trophic levels (3 and 4) were prioritized, with the more characteristically piscivorous species with larger gape sizes being the top ranked priority.

Mercury was sampled either by processing individual fish fillets or by compositing multiple fish using EPA method 7471A. PCBs were all composite samples due to the high cost of analysis. PCBs were analyzed for the full list of 209 PCB congeners using EPA method 1668A. Seventeen of the 26 waterbodies were sampled for selenium using EPA method 6010B.

All fish were immediately wrapped whole in food grade plastic bags and transported on water ice to the ADEQ sample preparation laboratory. There they were frozen in an industrial grade, non-cycling deep freezer until subsampling. To prepare samples for laboratory analysis, fish were partially thawed. The skin covering the fillet area was then removed using a ceramic knife and 30 grams of muscle was removed, homogenized using a laboratory mortar and pestle and placed in a pre-cleaned glass container and refrozen. Samples were shipped or delivered frozen to Arizona licensed laboratories for analysis. Fish processing methodology is described in more detail ADEQ's 2018 Standard Operating Procedures for Surface Water Sampling (ADEQ, 2018). Quality assurance followed ADEQ's 2015 Quality Assurance Plan.

RESULTS

Site Evaluation

Forty-one lakes were evaluated. Twenty-six sites were sampled, one site (Lake Mead) was a target site that was not sampled due to logistical problems, eight sites had access issues mostly related to boat ramps and six sites were sampled but too few fish were obtained (Figure 5, Appendix A).

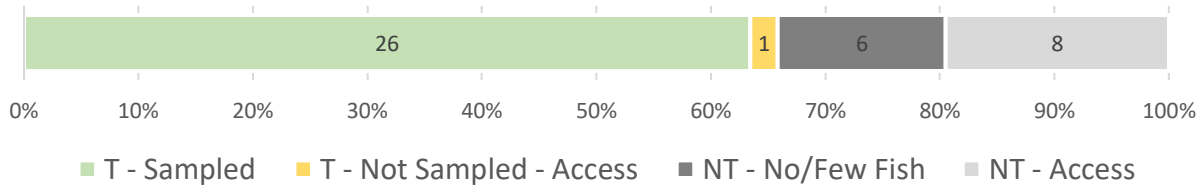

Figure 5. Site Evaluation. 26 lakes were sampled and 41 evaluated. T = Target. NT = Not Target.

Statewide Results

Thirty percent of Arizona's fishable lakes are estimated to be not supporting or in need of a fish consumption advisory. The probabilistic design estimates that there are **30 lakes** that need a fish advisory with a margin of error of 14.46% with 90 percent confidence (Figure 6, Table 2). Recall that Arizona currently has 22 fish advisories for lakes. Data from this study indicate that there are **at least eight to 23 additional lakes** that should have a fish advisory. **Sixty-three percent** of lakes support the fish consumption use and do not need a more restrictive fish advisory.

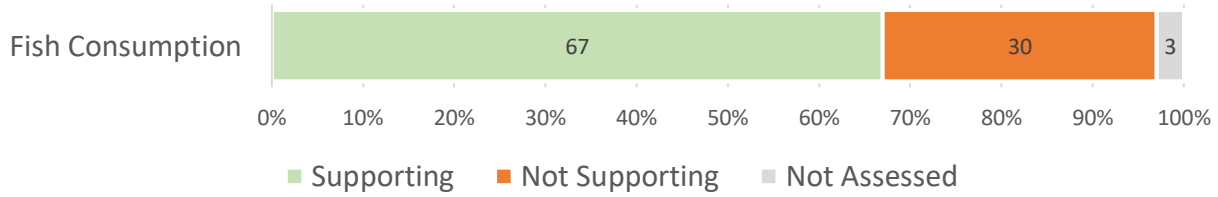

Figure 6. Fish consumption use support.

Table 2. Fish consumption use support showing margin of error with 90% confidence.

Use	Category	Count	Percent	Margin of Error
Fish Consumption	Supporting Use	18	66.67	14.92
Fish Consumption	Not Supporting Use	8	29.63	14.46
Fish Consumption	Not Assessed	1	3.70	5.98

Mercury is the cause for each of the lakes that were not supporting the fish consumption designated use. **Eight lakes** or **30%** did not meet the state standard for **mercury** of 0.3 mg/kg (Figure 7). **PCBs and selenium did not exceed health based limits** (see the 'Polychlorinated Biphenyls' and 'Selenium' sections).

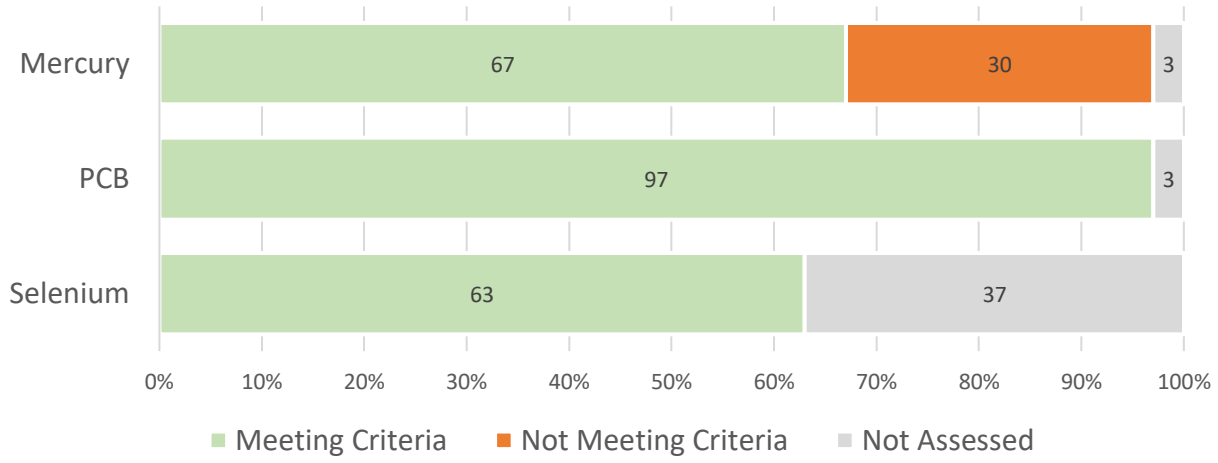

Figure 7. Parameters meeting standards or human health criteria.

Mercury

The median mercury concentration in fish tissue for Arizona is 0.22 mg/kg. The variation around the median is substantial with an inter quartile range of 0.23 mg/kg which means that typical mercury concentrations range from zero to 0.45 mg/kg. Figure 8 overlays the randomly selected fish tissue samples in **orange** with existing fish tissue data in **black**. Largemouth bass mercury concentrations were lower than typically seen during targeted sampling. Seven out of 13 largemouth bass sites were below the 25 percentile.

Seven of the 26 lakes already had an existing fish advisory (Appendix B). Sampling confirmed that mercury for all seven waterbodies with an existing advisory were still above the state standard of 0.3 mg/kg for specific species (Appendix B). **A new fish advisory was issued for Santa Fe Reservoir to limit consumption of Black Crappie in January 2020** based on five individual fish. **Patagonia Lake** had a composite mercury fish tissue concentration of **0.37 mg/kg for flathead catfish**. A fish advisory was not issued for Patagonia Lake because composite samples do not allow for variance in the data to be calculated. Follow up sampling has been scheduled for Patagonia Lake to verify if the flathead catfish exceed the standard.

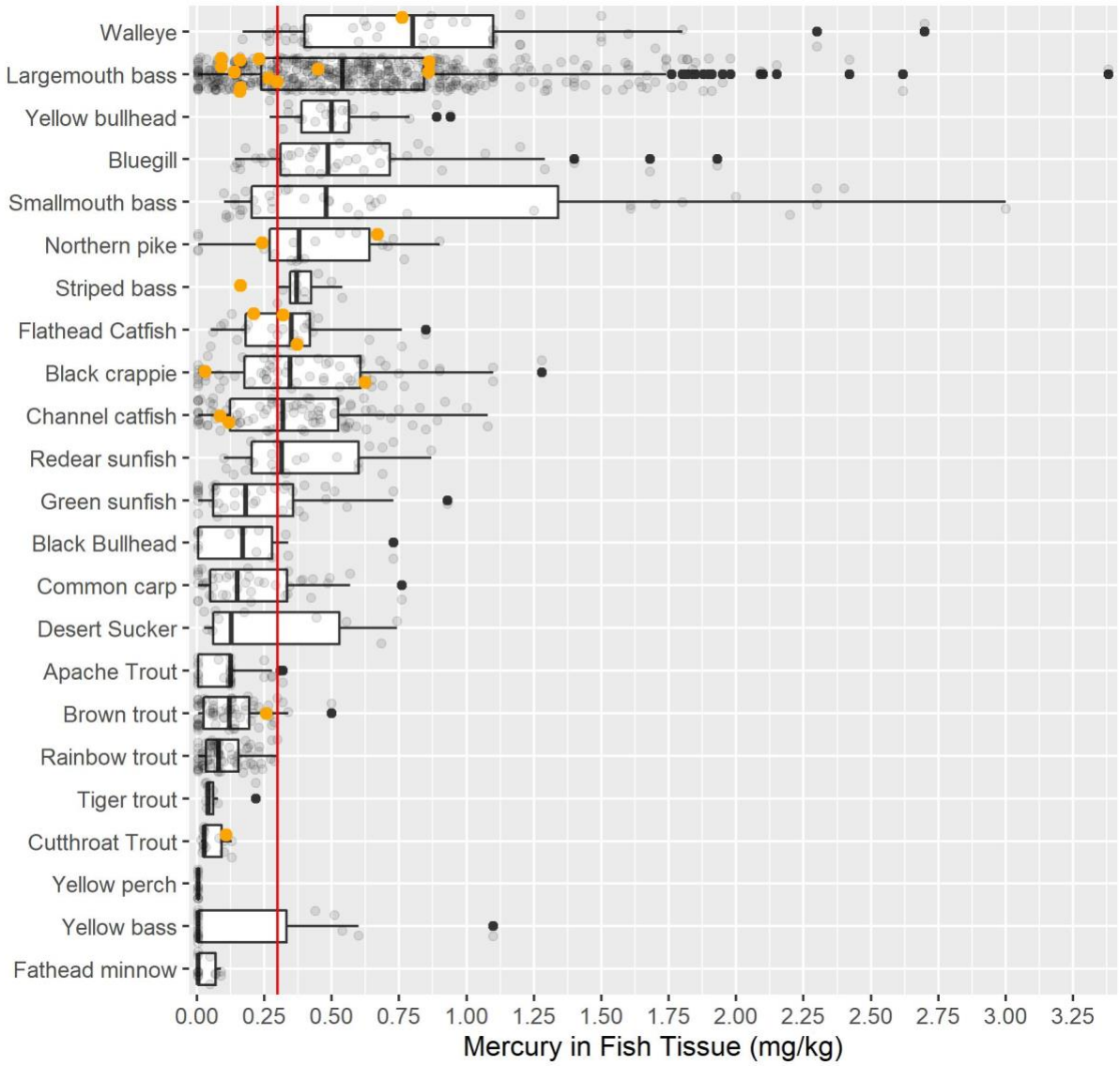

Figure 8. Mercury in Arizona Fish Species. Orange circles represent randomly picked lakes and grey circles are mercury results from previous targeted monitoring. Box plots show the 25th percentile, median and 75th percentile along with black circles representing outliers. The red line represents the state fish tissue standard of 0.3 mg/kg for mercury.

Polychlorinated Biphenyls

All lakes had **PCBs concentrations below the EPA health limit of 6000 pg/g** (Appendix B). Luna Lake and Lake Mary had the highest total PCB concentrations with 26 and 22 of the 209 congeners detected respectively. Congeners 105 and 118 were detected at the majority of the lakes (Figure 9, Appendix B).

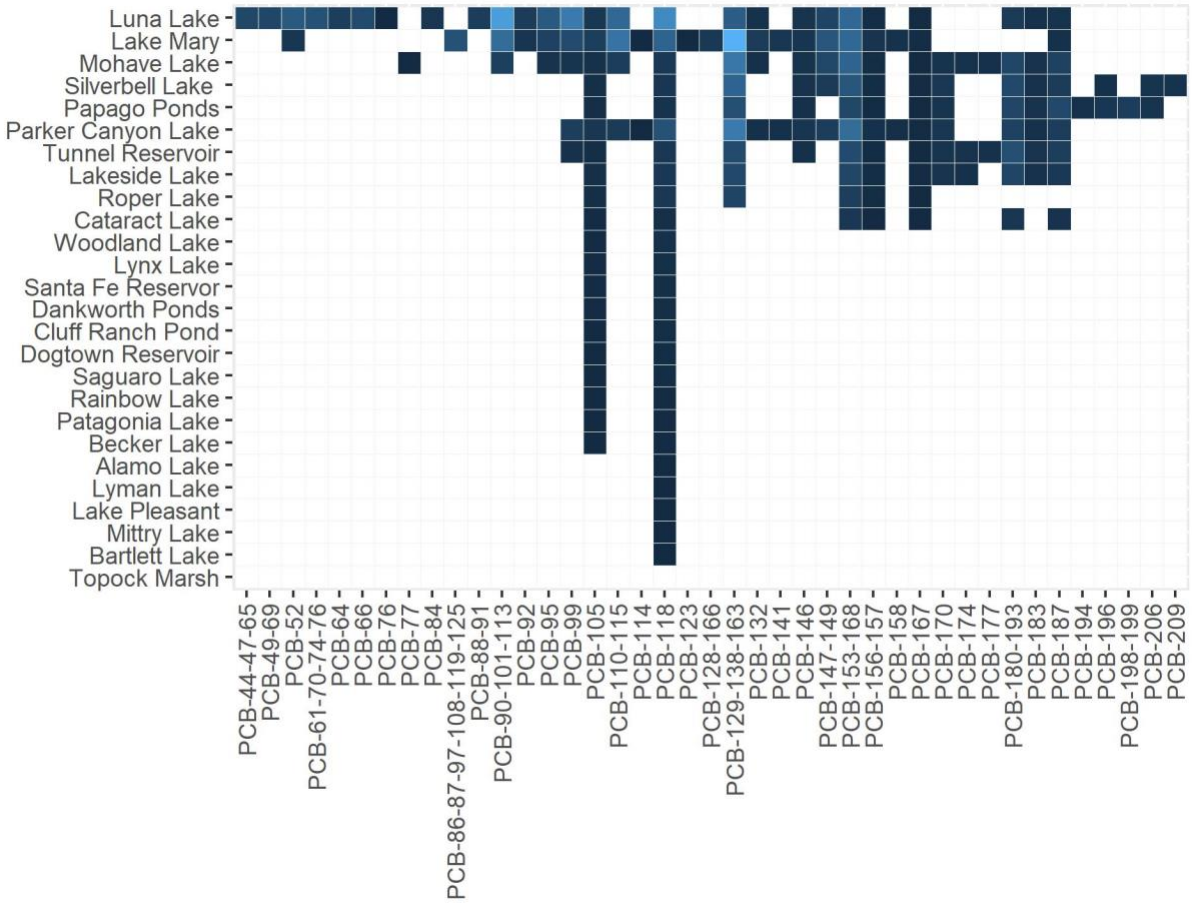

Figure 9. PCB Congener data sorted by highest total PCB concentration. Individual concentrations are from 100 pg/g, 200 pg/g and 300 pg/g.

Selenium

All sampled lakes were **below the health based limit of 5.9 mg/kg for selenium** (EPA 1999). Selenium was only detected at one site (Lake Mohave). That result, 3 mg/kg was below the health based limit of 5.9 mg/kg. The result was below. Selenium was not sampled at 9 of the 27 target sites (Figure 6, Appendix B).

CONCLUSIONS

Arizonans should engage in activities that promote an active lifestyle and a good diet. Fishing and eating fish is a great way to be active and improve your diet. Arizonans should follow the national guidelines in Figure 1 unless there is a specific advisory on a lake.

This study shows that PCBs and selenium are **below EPA health limits** for Arizona's lakes. **Mercury is a concern for 30% of lakes** but can be mitigated by eating smaller portions or choosing fish that are lower on the food chain such as trout. Follow the advice in Figure 1 unless there is lake specific advisory in place. Figure 1 does not include all fish that are typically consumed in Arizona. The following Arizona fish are typically higher in mercury and may be considered as 'good choices' for fish. These fish **should be limited to 1 or fewer servings per week.**

- Walleye

- Largemouth bass
- Yellow bullhead
- Bluegill
- Small mouth bass
- Northern pike, and
- Striped bass

FUTURE STUDY AND LESSONS LEARNED

There are always lessons learned when designing a study for the first time. The following is a list of lessons learned or potential future study.

- Do not use multiple methods for collecting fish tissue. Always use individual fish for fish tissue in mercury (versus composite sampling).
- Sample sites in order and do not drop sites without good reason. Lake Mead should have been sampled but was skipped due to logistical considerations. This increases error.
- Increase the sample size to reduce margin of error.
- Sample for additional pollutants that are common advisories/impairments in other states.
- Access to lakes due to issues with the boat ramp was a significant issue affecting 8 lakes. Explore other ways to gain access to these lakes.
- Sample all consumable fish species in the lake. Most samples just took one species due to budget restrictions. Lakes in this study had a median of four species present at each lake according to Arizona Game and Fish data (AGFD, 2020).
- Reevaluate the 100 lakes included in the sample frame to ensure all waterbodies are included. Consider adding streams where people fish.
- Examine where the PCBs in Luna Lake and Lake Mary came from.
- Sample individual fish in Patagonia Lake for mercury to confirm if an advisory is needed.

REFERENCES

ADEQ (2015). Quality Assurance Program Plan for Surface Water Quality Sampling, Phoenix, AZ.

ADEQ (2016). Arizona's 2016 Clean Water Act Assessment.

ADEQ (2018). Standard Operating Procedures for Surface Water Quality Sampling, Phoenix, AZ.

ADEQ (2020). Arizona's Comprehensive Water Quality Monitoring Strategy. https://static.azdeq.gov/wqd/reports/swqms_2020.pdf

AZSOS (2020). Arizona Administrative Code. Title 18. Chapter 11. Arizona Surface Water Standards. https://azsos.gov/rules/arizona-administrative-code

CDC (2020). Center for Disease Control. Obesity Data and Trends. https://www.cdc.gov/obesity/data/databases.html

EPA (1979). Water-related environmental fate of 129 priority pollutants, Vol. II. Washington, DC: U.S. Environmental Protection Agency, 40-2 to 43-10. EPA 440/4-79-029a.

EPA (1999). Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 2. https://19january2017snapshot.epa.gov/sites/production/files/2015-06/documents/volume2.pdf

EPA/FDA (2020). Fish Consumption Advice. https://www.fda.gov/food/consumers/advice-about-eating-fish#:~:text=The%202015%2D2020%20Dietary%20Guidelines%20for%20Americans%20recommends%3A,that%20are%20lower%20in%20mercury.

USDA (2020). 2015-2020 Dietary Guidelines. https://health.gov/sites/default/files/2019-09/2015-2020_Dietary_Guidelines.pdf

APPENDIX A – SITE EVALUATION RESULTS

Random#	Site	ID	Latitude	Longitude	Evaluation Status
1	Lake Mead	CGMEA-SENT	36.04861	-114.741	Target Not Sampled - Access
2	Saguaro Lake	SRSAG-BJ	33.57222	-111.516	Target Sampled
3	Cataract Lake	CGCAT-A	35.25167	-112.216	Target Sampled
4	Lynx Lake	MGLYN-A	34.52167	-112.387	Target Sampled
5	Woodland Lake	LCWOR-A	34.12681	109.9529	Target Sampled
6	Becker Lake	LCBEC-A	34.15564	-109.304	Target Sampled
7	Lake Mohave	CLMOH-CRMR	35.49167	-114.686	Target Sampled
8	Long Lake	LCLLL-A	34.78056	-111.204	Not Target - Access
9	Lake Mary (upper)	LCMAU-B	35.06111	-111.49	Target Sampled
10	Chaparral Park Lake	MGCHA-B	33.51333	-111.908	Not Target - Sampled No/few Fish
11	Lyman Lake	LCLYM-B	34.36047	-109.364	Target Sampled
12	Roper Lake	UGROP-B	32.75639	-109.706	Target Sampled
13	Lakeside Lake	SCLAK-B	32.18632	-110.817	Target Sampled
14	Whitehorse Lake	VRWHH-B	35.11592	-112.011	Not Target - Sampled No/few Fish
15	Alvord Lake	MGALV-C	33.37417	-112.136	Not Target - Sampled No/few Fish
16	Kennedy Lake	SCKEN-B	32.18005	-111.009	Not Target - Sampled No/few Fish
17	Riverview Lake	SRRPL-A	33.43028	-111.875	Not Target - Sampled No/few Fish
18	Sahuarita Lake	SCSAH-A	31.97167	-110.967	Not Target - Access
19	Patagonia Lake	SCPAT-B	31.49861	-110.848	Target Sampled
20	Watson Lake	VRWAT-B	34.59056	-112.416	Not Target - Sampled No/few Fish
21	Alamo Res.	BWALA-B	34.25605	-113.576	Target Sampled
22	Horseshoe Lake	VRHSR-BR	33.98689	-111.718	Not Target - Access
23	Cluff Ranch Ponds	UGCRC-B	32.80556	-109.863	Target Sampled
24	Luna Lake	UGLUN-B	33.82889	-109.094	Target Sampled
25	Topock Marsh	CLTOP-OUT	34.7375	-114.49	Target Sampled
26	Water Ranch	MGWTR-MID	33.36306	-111.737	Not Target - Access
27	Rainbow Lake	LCRAI-B	34.15028	-109.984	Target Sampled
28	Mittry Lake	CLMIT-A	32.82028	-114.461	Target Sampled
29	Santa Fe Lake	CGSAT-A	35.24194	-112.187	Target Sampled
30	Parker Canyon Lake	SCPAK-A	31.42778	-110.456	Target Sampled
31	Papago Ponds	MGPAP-B	33.45306	-111.948	Target Sampled
32	Lake Pleasant	MGPLE-B	33.90611	-112.243	Target Sampled

Random#	Site	ID	Latitude	Longitude	Evaluation Status
33	Silverbell	SCSIL-B	32.28438	-111.032	Target Sampled
34	Dogtown Res.	CGDOG-A	35.21167	-112.127	Target Sampled
35	Tunnel Reservoir	LCTUN-B	34.03167	-109.443	Target Sampled
36	McClelland Lake	BWMCL-A	35.22089	-112.286	Not Target - Access
37	Blue Ridge Res.	LCBRR-NLS	34.55364	-111.194	Not Target - Access
38	Soldiers Lake	LCSOI-A	34.79667	-111.233	Not Target - Access
39	Desert West	MGDSW-E	33.47611	-112.194	Not Target - Access
40	Dankworth	UGDAN-B	32.72028	-109.705	Target Sampled
41	Bartlett Lake	VRBAR-B	33.8525	-111.618	Target Sampled

APPENDIX B – FISH TISSUE DATA

Selenium health based limit = 5.9 mg/kg (EPA, 1999)
Mercury standard = 0.3 mg/kg (Arizona Administrative Code Title 18, Chapter 11, 2020).
Total PCB health based limit = 6,000 pg/g (EPA, 1999)
ND = Not detected.

Waterbody	Date	Species	Selenium (mg/kg)	Mercury (mg/kg)	Advisory	Mercury Type	Total PCB (pg/g)	# Congeners
Santa Fe Reservoir	5/14/2019	Black crappie	Not sampled	0.622	Yes, New	Individual	19.6	2
Parker Canyon Lake	9/13/2019	Largemouth bass	Not sampled	0.86	Yes	Composite	260	7
Alamo Lake	10/15/2017	Largemouth bass	ND	0.86	Yes	Composite	4.8	1
Lyman Lake	3/28/2018	Walleye	ND	0.76	Yes	Composite	4.1	1
Lake Mary	8/23/2017	Northern pike	ND	0.67	Yes	Composite	1941.8	22
Becker Lake	5/13/2018	Largemouth bass	ND	0.45	Yes	Composite	8.4	2
Bartlett Lake	10/4/2018	Flathead Catfish	ND	0.32	Yes	Composite	2	1
Patagonia Lake	9/27/2017	Flathead Catfish	ND	0.37	No	Composite	10.1	2
Lake Pleasant	9/15/2018	Flathead Catfish	ND	0.21	No, but listed for other species	Composite	4	1
Parker Canyon Lake	8/17/2018	Channel catfish	ND	0.12	No, but listed for other species	Composite	1057.7	18
Dogtown Reservoir	5/14/2019	Largemouth bass	Not sampled	0.2975	No	Individual	15.9	2
Dankworth Ponds	4/30/2019	Largemouth bass	Not sampled	0.266	No	Individual	19.6	2
Tunnel Reservoir	4/5/2019	Brown trout	ND	0.256	No	Individual	598.4	14
Rainbow Lake	3/1/2018	Northern pike	ND	0.24	No	Composite	10.4	2
Cluff Ranch Pond	4/30/2019	Largemouth bass	Not sampled	0.23	No	Individual	19	2
Roper Lake	4/30/2019	Largemouth bass	ND	0.16	No	Individual	210.6	6
Cataract Lake	8/16/2017	Largemouth bass	ND	0.16	No	Composite	140.3	7
Mohave Lake	11/28/2017	Striped bass	3	0.16	No	Composite	1053.3	20
Lakeside Lake	4/10/2019	Largemouth bass	ND	0.158	No	Individual	457.7	11
Lynx Lake	5/15/2019	Largemouth bass	Not sampled	0.138	No	Individual	22.9	2
Luna Lake	4/8/2019	Cutthroat Trout	Not sampled	0.1086	No	Individual	2507.5	26
Mittry Lake	11/20/2018	Largemouth bass	ND	0.089	No	Composite	3.1	1
Saguaro Lake	10/10/2017	Largemouth bass	ND	0.089	No	Composite	14.8	2

Waterbody	Date	Species	Selenium (mg/kg)	Mercury (mg/kg)	Advisory	Mercury Type	Total PCB (pg/g)	# Congeners
Woodland Lake	3/9/2018	Channel catfish	ND	0.086	No	Composite	27.7	2
Topock Marsh	10/1/2019	Black crappie	Not sampled	0.0302	No	Individual	0	0
Papago Ponds	10/31/2018	Bluegill	ND	ND	No	Composite	661.4	15
Silverbell Lake	11/8/2018	Common carp	ND	ND	No	Composite	750.5	15