

Urban recreational fisheries: Implications for public health in metro-Phoenix

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Arizona Game and Fish Department Community Fishing Program (CFP)

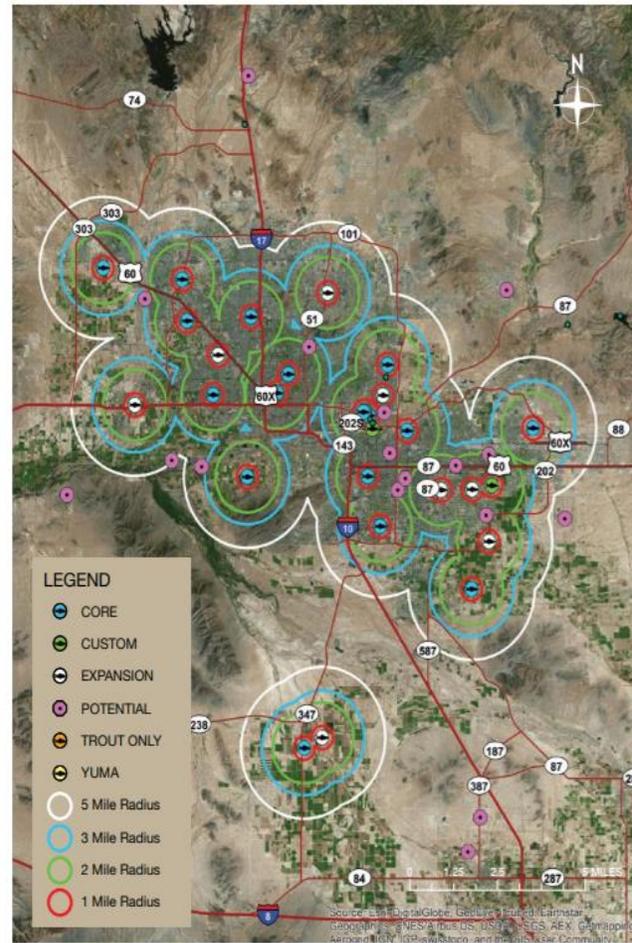
- Largest urban fishing program of its kind in the country
- Currently includes 45 waters across 21 municipalities in the state
- Regularly stocks channel catfish (spring and fall), bluegill (once in spring), and rainbow trout (winter) in all incorporated waters
- Although no longer stocked, many waters sustain resident populations of bass, grass carp and common carp, and other types of sunfishes such as redear and green
- Total population living in a city/town with urban fishing waters: **3,794,403**

Cities where the CFP is currently established.

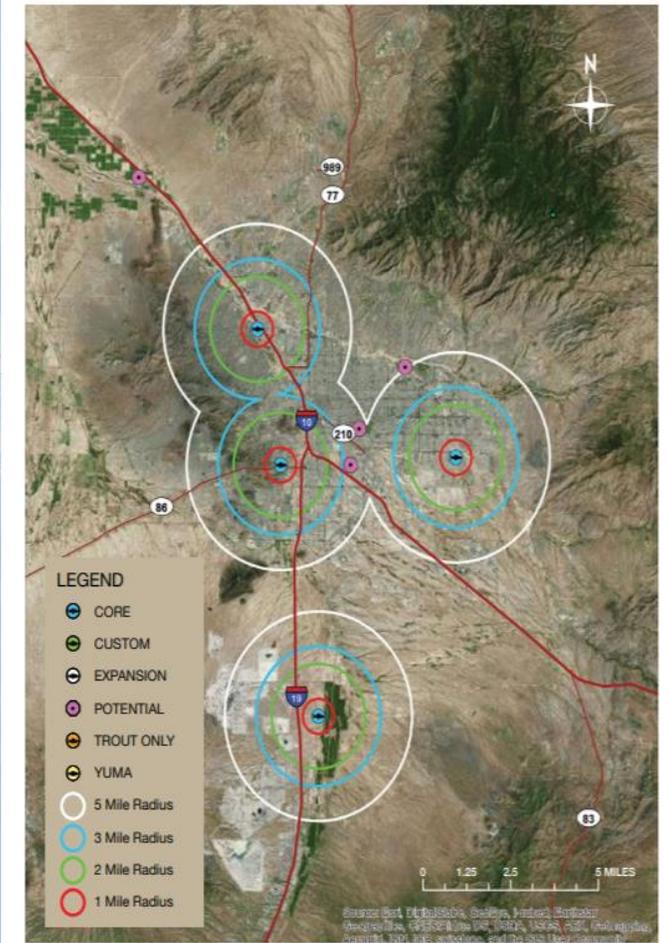
NAME	TYPE	COUNTY	POPULATION 2010
Somerton	City	Yuma	14,287
Payson	Town	Gila	15,301
Sahuarita	Town	Pima	25,259
Maricopa	City	Pinal	43,482
Avondale	City	Maricopa	76,238
Yuma	City	Yuma	93,064
Surprise	City	Maricopa	117,517
Peoria	City	Maricopa	154,065
Tempe	City	Maricopa	161,719
Gilbert	Town	Maricopa	208,453
Scottsdale	City	Maricopa	217,385
Glendale	City	Maricopa	226,721
Chandler	City	Maricopa	236,123
Mesa	City	Maricopa	439,041
Tucson	City	Pima	520,116
Phoenix	City	Maricopa	1,445,632

Source: Census population 2010

- Since these urban waters are artificially constructed they are not recognized as “waters of the US” and do not fall under the provisions Clean Water Act of 1972
- Regular and comprehensive monitoring for contaminants in urban waters is neither required nor conducted
- Only few fish are sporadically tested for mercury prior to stocking
- A prior study has documented that approximately 60% of surveyed anglers consume the fish they catch from urban ponds (Pulford et al., 2017).



PHOENIX



TUCSON

Methods

- Twenty-one fish were caught by hook and line from 11 urban lakes and ponds located across metro-Phoenix, the majority of which are part of AGFD's Community Urban Fishing Program



Water Quality

- Chemical water quality parameters were also collected alongside fish samples at the majority of sampling sites.

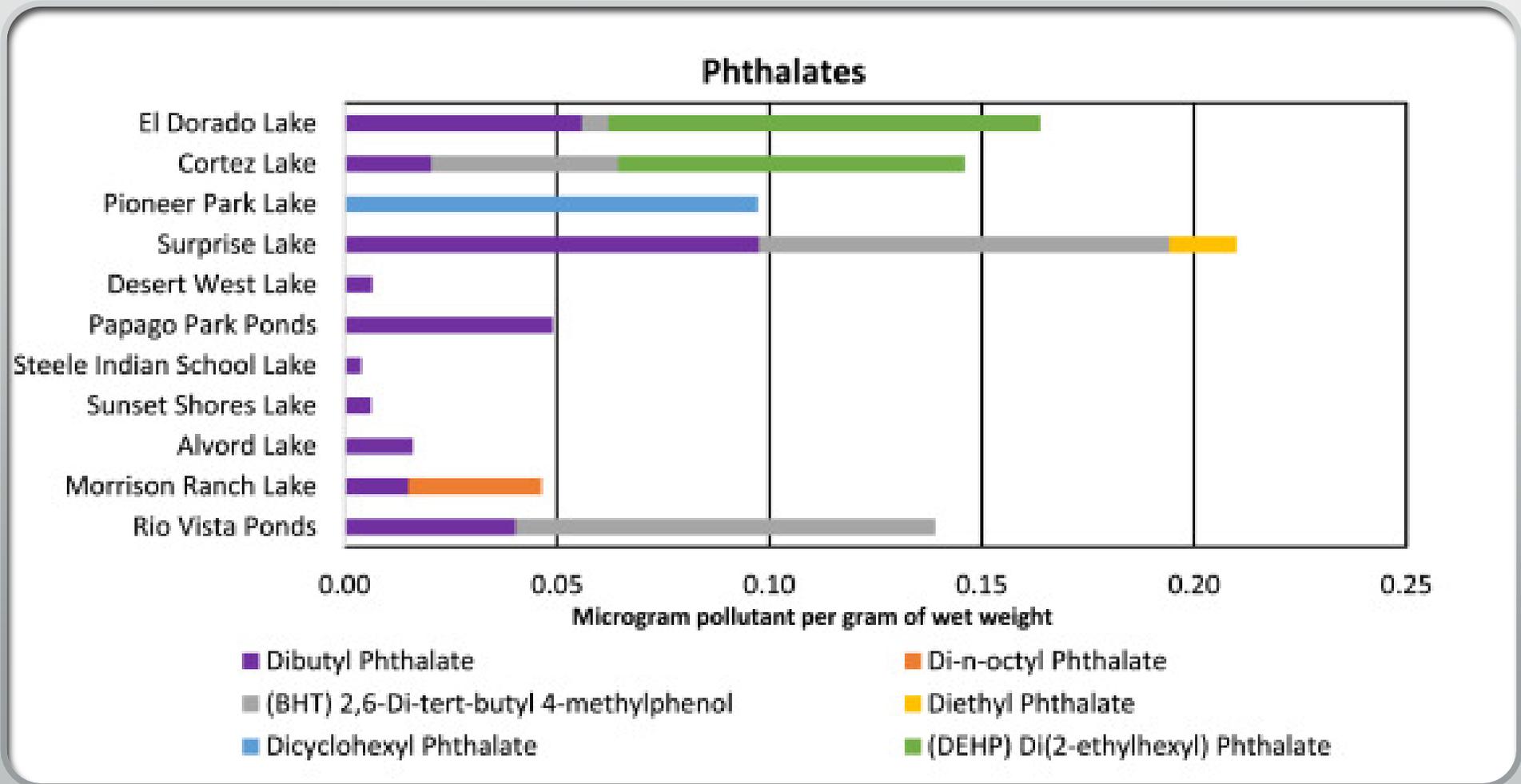
	Rio Vista Ponds	Morrison Ranch Lake ^a	Alvord Lake	Sunset Shores Lake ^a	Steele Indian School Lake	Papago Park Ponds	Desert West Lake	Surprise Lake	Pioneer Park Lake	Cortez Lake	El Dorado Lake
Area (ha)	1	N/A	10	N/A	1	2.4	2	2	2	1.2	1.4
Maximum Depth (m)	4.3	N/A	7.6	N/A	3.7	2.4	4.6	3.7	3.7	4.3	3.0
Temperature (C°)	21	20	24	N/A	20	24	22	23	22	22	22
Dissolved Oxygen (mg/L)	6.6	7.4	6.5	N/A	6.6	5.0	7.2	6.4	6.8	6.3	6.8
pH	7.5	8.4	7.7	N/A	7.8	7.3	7.0	7.8	7.5	8.2	7.8
Total Suspended Solids (g/L)	0.53	0.4	1.2	N/A	0.5	0.4	1.3	0.5	0.41	2.5	0.6
Nitrate-N (mg/L)	0.49	0.53	0.52	N/A	0.34	0.24	0.27	0.32	0.42	0.31	0.44

^a Not part of AGFD Community Fishing Program.

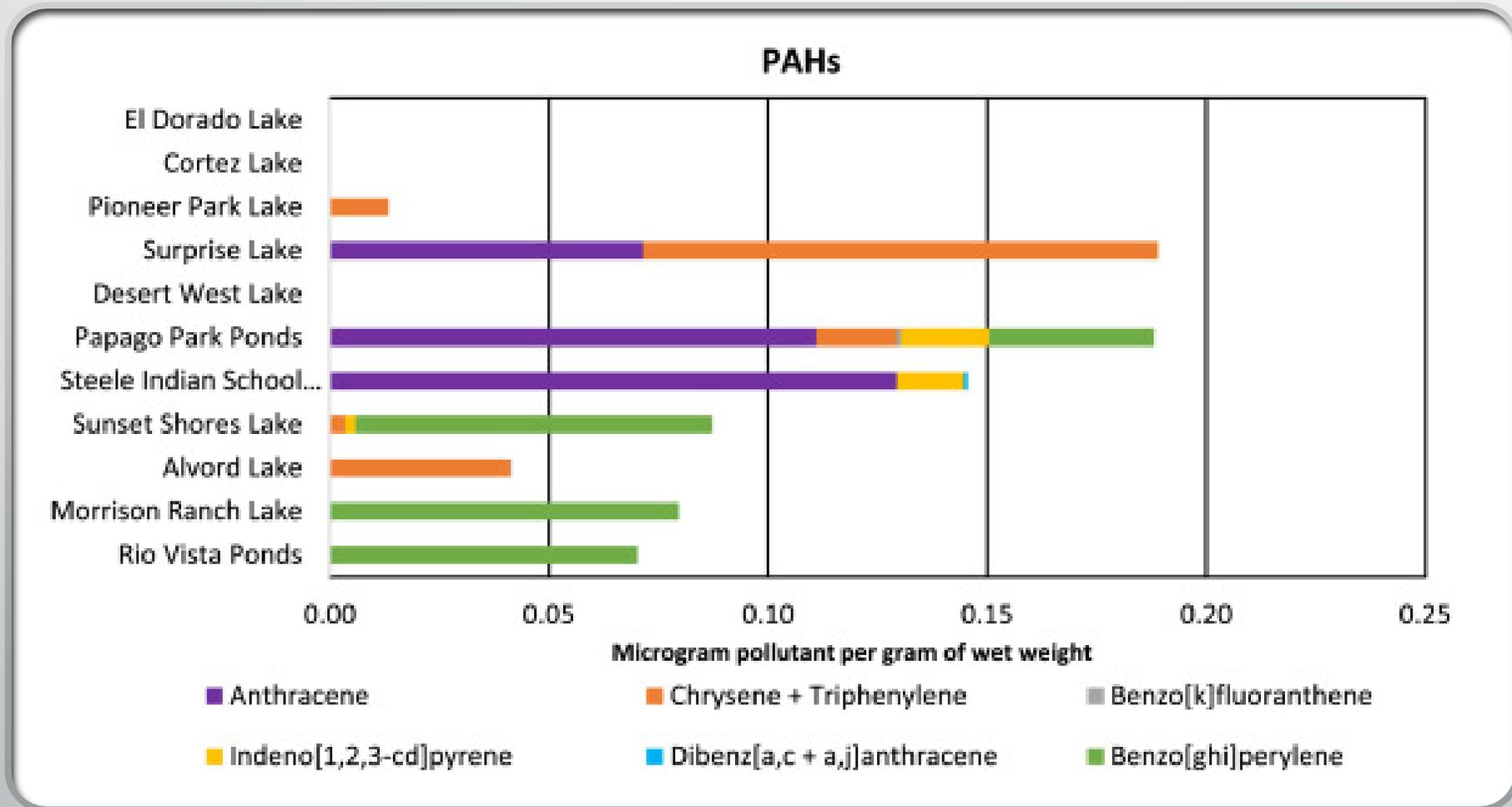
Sample Processing (Organic Contaminants)

- For each fish, a 5 g tissue sample was extracted and spiked with 30 mg of p-terphenyl as recovery surrogate, and then homogenized in 25 g of NaSO₄ to remove excess water.
- Homogenized samples were then spun on a rotor for 48 h in 50 mL of hexane. The hexane extracts were passed through several cleanup columns to remove larger molecules (e.g. Biobeads, BioRad) and polar compounds (e.g. Florisil).
- Samples were concentrated with nitrogen gas to a final volume of 0.5 mL, and spiked with tetracosane as an internal standard. All samples were analyzed for organic contaminants using a Varian 3800 gas chromatograph in tandem with a Saturn 2200 electron ionization mass spectrometer.

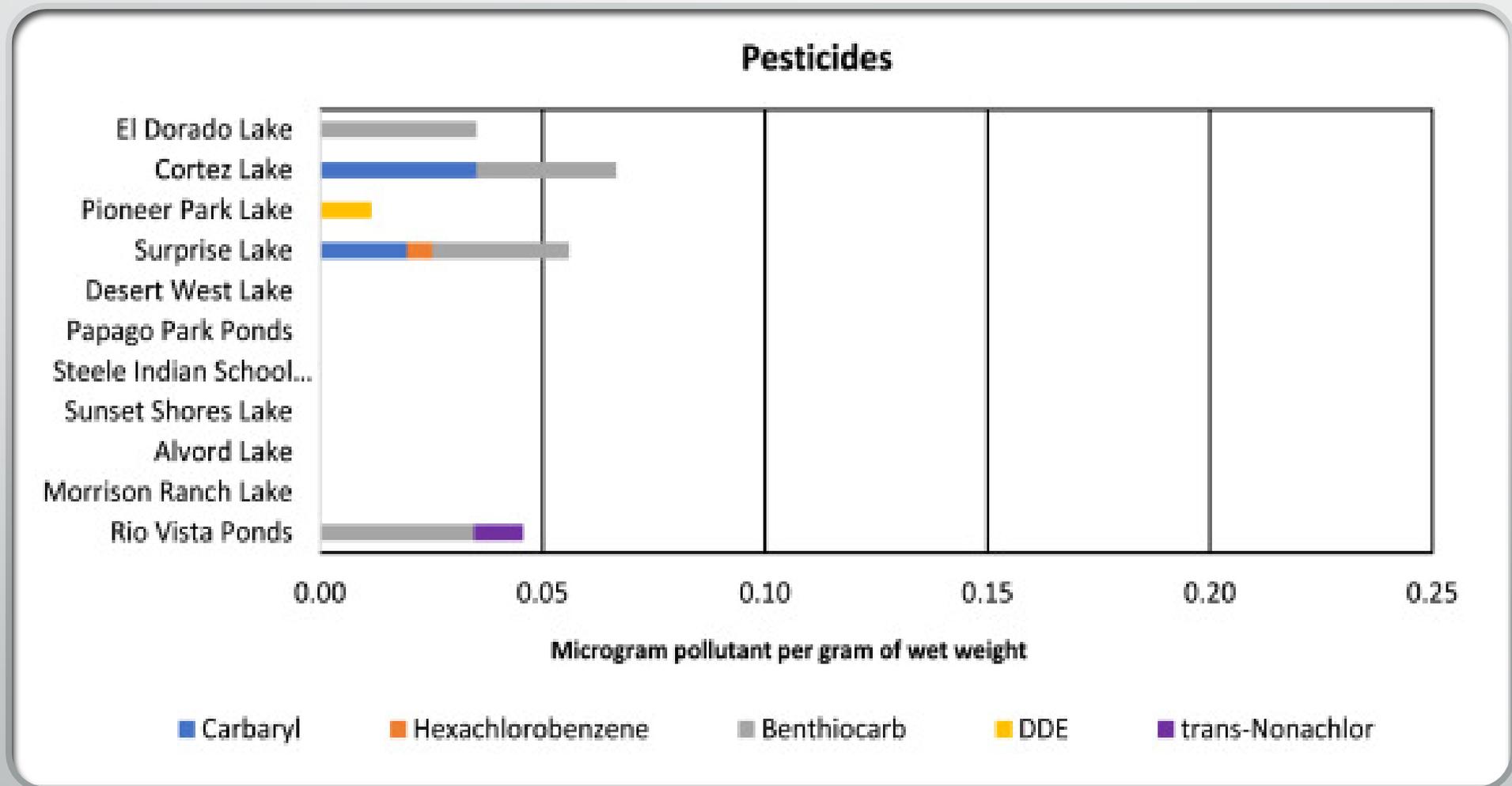
Organic Contaminants Results (by sampling site)



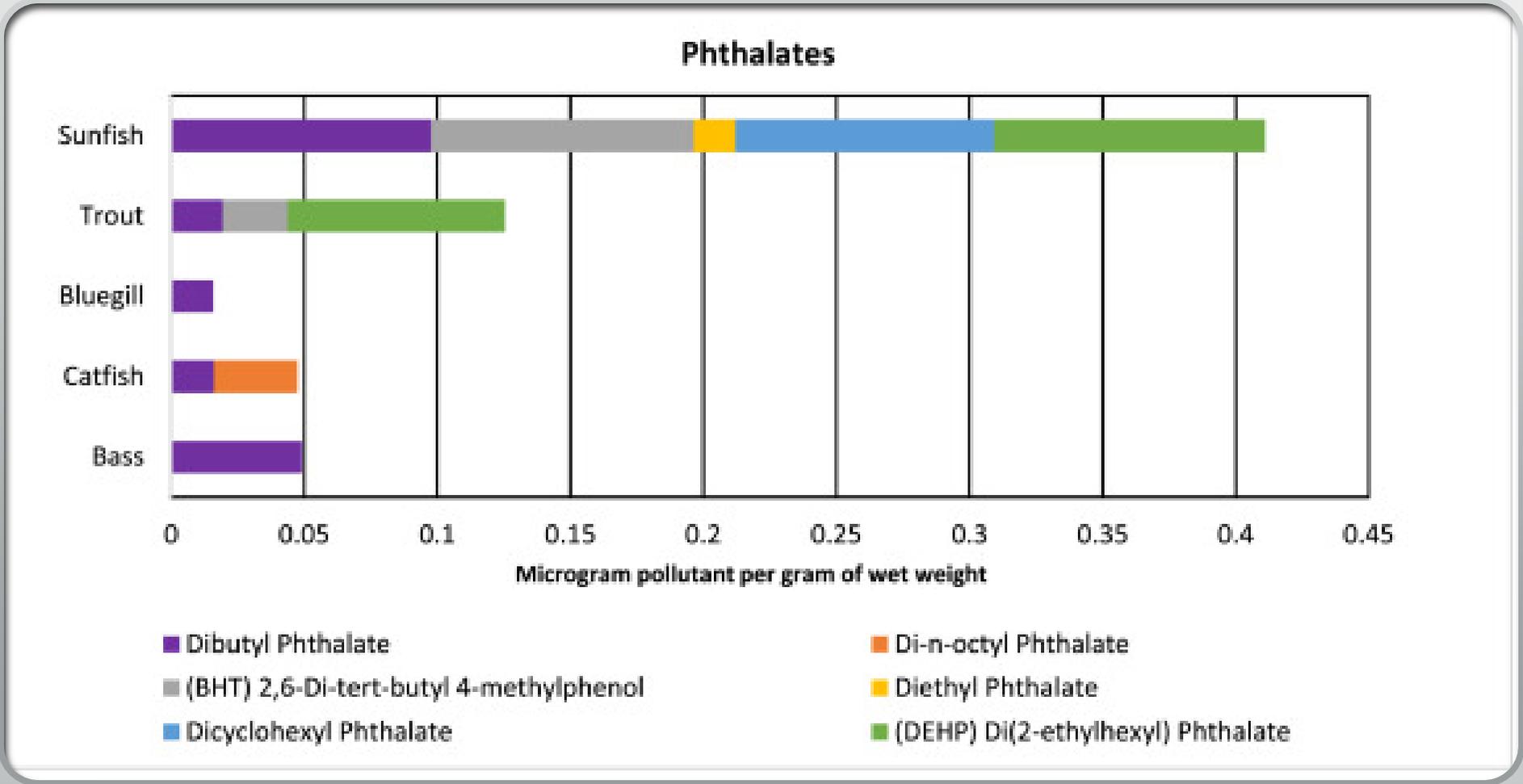
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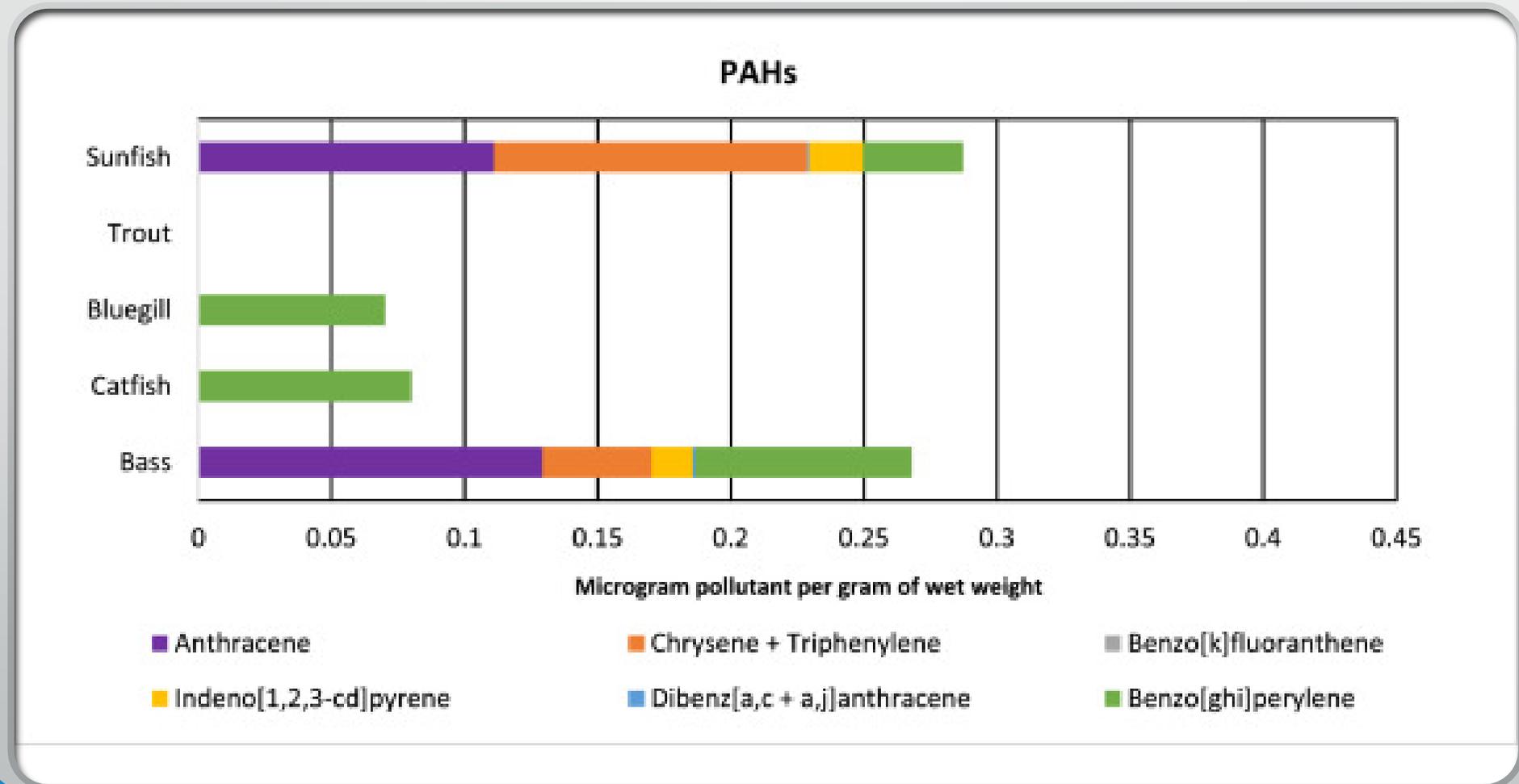
Organic Contaminants Results (by sampling sites)



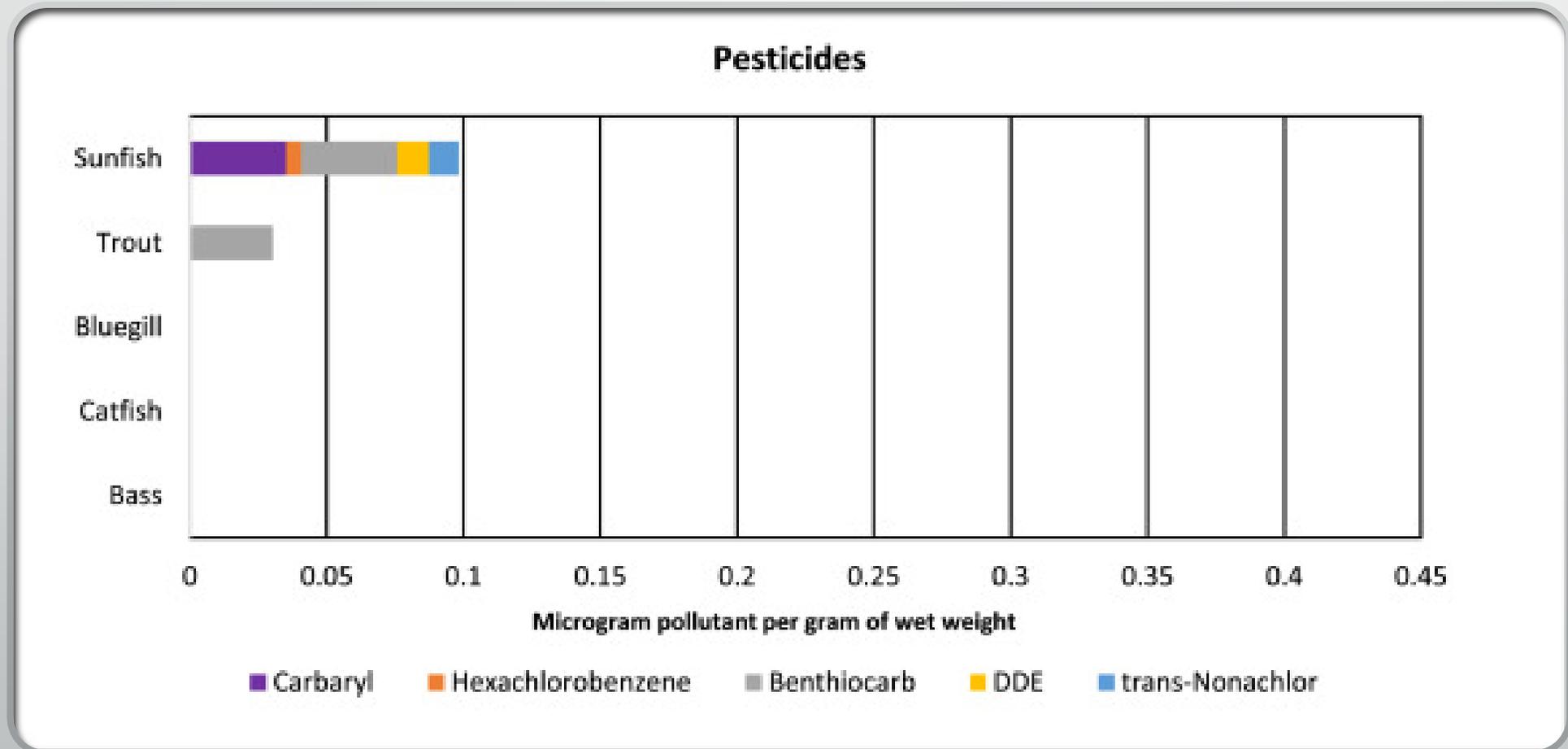
Organics Contaminants Results (by fish)



Organic Contaminants Results (by fish)



Organic Contaminants Results (by fish)



Sample Processing (Metal Contaminants)

- Thirteen of the 21 fish were sub sampled and run for for 41 different elements by Quadrupole ICP-MS (ThermoFisher Scientific iCAP Q, with CCT option), although only 16 selected elements of interest are reported here.
- For each fish sample, 0.2 g of tissue was digested in reverse aqua regia (1 part trace metal (TM) grade 12 M hydrochloric acid and three parts (TM) grade 15.6 M nitric acid) on a 120 degree C hotplate for 24 h.
- Following the digestion period, the sample was then diluted up to a volume of 5 mL with nitric acid and subsequently run.

Metal Contaminant Results (by fish)

Table 2

Maximum metal concentrations (ppm or micrograms of metal per gram of fish wet weight) detected in recreationally-caught fish in metro-Phoenix.

	Mg	Al	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Ce	Pb	Hg
Bluegill	314.6	8.51	0.141	0.157	0.002	0.158	0.167	4.683	0.056	0.301	2.453	0.299	0.000	0.001	0.002	0.163
Catfish	362.3	5.34	0.090	0.299	0.009	0.375	0.227	4.909	0.018	0.303	4.844	0.331	0.001	0.003	0.011	0.115
Bass	334.5	46.92	0.031	0.163	0.004	0.037	0.369	4.203	0.154	0.289	5.621	0.160	0.001	0.014	0.003	0.160
Sunfish	308.4	4.57	0.041	0.262	0.004	0.075	0.162	4.955	0.080	0.373	4.162	0.243	0.000	0.015	0.015	0.044

Action Levels

- Other than for mercury, no safety standards are known specifically for fish consumption for any of the metals or organic contaminants detected in this study.

Table 3

Oral reference dose and calculated action level for metal contaminants (NA = not available).

	Mg	Al*	Cr*	Mn	Co	Ni	Cu	Zn	As*	Se	Rb	Sr	Cd	Ce	Pb*	Hg*
EPA Oral Reference Dose (IRIS) (mg kg ⁻¹ day)	NA	0.0004	1.5	0.14	NA	0.02	NA	0.3	0.0003	0.005	NA	0.6	0.003	NA	0.005	0.0001
Action Level (ppm) for a 70 kg person	–	0.59	2234	208	–	29.7	–	446	0.45	7.4	–	893	4.5	–	7.4	0.15

* Pb adopted from [Edition \(2011\)](#).

* Cr³⁺ assumed to be most common in biological material ([Langard and Norseth, 1979](#)).

* Inorganic As only available.

* Hg assumed to be methylmercury.

Table 4

Oral reference dose and calculated action level for organic contaminants.

	Dibutyl Phthalate	Diethyl Phthalate	DEHP	Anthracene	Carbaryl	Hexachlorobenzene	Anthracene
EPA Oral Reference Dose (IRIS) (mg kg ⁻¹ day)	0.1	0.8	0.02	0.3	0.1	0.0008	0.3
Action Level (ppm) for a 70 kg person	148.9	1191	30	446	149	1.19	447

- Similar to EPA's screening value methodology, the Action Level (ppm) = (Oral Reference in mg kg⁻¹ body weight x 70 kg)/(0.11 kg serving x 3 servings per week/7 days/week).

Aluminum Oral Reference Dose

- Upon receiving feedback from the EPA on the study, we were told the oral reference dose we used for Aluminum is actually based on Aluminum Phosphate.
- Therefore, it may not be an accurate representation to say that our detected contaminant concentration exceeded available safety thresholds by approximately 80 times since an appropriate safety threshold is currently not available for Aluminum in this context.
- An important outcome of this study is that it shows more appropriate references for standards of safe contaminants thresholds for monitoring are needed.

Public Health Implications

- The Arizona Game and Fish Department plans to expand the Community Fishing Program in order to provide 200,000 anglers with the opportunity to fish within five minutes from their homes by 2025.
- At least one major city within every state in the union has some sort of community/urban fishing program.

Main Points

- Fish stocked in urban ponds throughout metro-Phoenix for recreation contain a variety of PAH's, phthalates, and pesticides, and metals.
- Mercury and Aluminum were found in concentrations that are potentially harmful to humans.
- Oral reference doses are missing for several organic contaminants.
- Safety limit concentrations for fish consumption only exist for Mercury and more need to be determined for metals such as Aluminum.
- The current wording of the Clean Water Act in the classification of "waters of the US" allows urban ponds in many community fishing programs across the country to go unmonitored, posing a possible public health hazard.

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