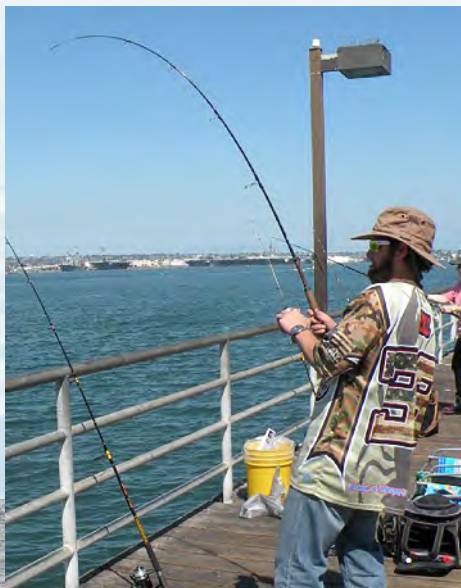


# San Diego Bay Fish Consumption Study



Steven J. Steinberg  
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*Southern California Coastal Water Research Project*

SCCWRP Technical Report 976

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*Identifying fish consumption patterns of anglers in San Diego Bay*

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*Southern California Coastal Water Research Project*

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### **San Diego Bay Fish Consumption Study website**

<http://www.sccwrp.org/fishconsumption>

### **QR code for study website**



## EXECUTIVE SUMMARY

The California Regional Water Quality Control Board, San Diego Region considers San Diego Bay one of the most important and valuable resources in the Southern California region. The bay provides multiple beneficial uses for both human use and natural services including habitat for fish and wildlife, extensive commercial and industrial economic benefits, and recreational opportunities to residents and visitors. It is imperative to protect its chemical, physical, and biological integrity so the many benefits of San Diego Bay may be enjoyed by future generations.

We undertook this study to gain a more comprehensive understanding of fishing activity and consumption than previously available for San Diego Bay. This information may be useful in supporting a future assessment of human health risks associated with consumption of fin fish from the bay. In 2013, the Office of Environmental Health Hazard Assessment (OEHHA) released their health advisory and consumption guidelines for San Diego Bay (OEHHA 2013). However, at the time of these recommendations, no recent study of fishing activity was available that provided a current understanding of how many anglers were consuming fish from the bay, and, if so, in what amounts. In particular, we sought to differentiate how many anglers are fishing for recreation (anglers practicing catch and release) versus those who keep and consume some portion of their catch.

This study was designed to interview a representative sample of anglers fishing in San Diego Bay from May 1, 2015 through April 30, 2016. We conducted field interviews of anglers at common fishing locations (boat landings, piers, and shoreline locations) surrounding the bay. The study design accounted for both geographically and culturally relevant site selection to ensure adequate coverage of all areas of the bay. Our objective was to provide consumption data specifically for fin fish consumed from San Diego Bay and to provide a basis for developing locally relevant recommendations. Additionally, the findings of this study provide valuable information for improving outreach and education to specific, higher risk segments of the fishing population and for guiding contaminant studies to monitor fish that people consume. In developing this study of fishing activity and consumption in San Diego Bay we focused on three key questions:

What are the consumption rates for anglers in San Diego Bay and how do they relate to advisory recommendations?

How do socio-economic differences relate to differences in consumption rates?

How do catch and consumption rates vary in space and time by location around the bay and time of year?

We reviewed survey questions and methods used in prior consumption studies conducted in California (San Diego County Department of Health Services 1990, SCCWRP 1994, Environmental Health Coalition 2005, SFEI 2000, Shilling et al. 2010, Shilling et al. 2014, EHIB 1994 and OEHHA 1994) to ensure data comparability wherever possible. Additional questions were added to capture sociospatial data to correlate with existing GIS-based data as an enhancement to the socioeconomic information for the study.

We approached a total of 1549 anglers in San Diego Bay. Overall, Pier Anglers were approached most often (62%), followed by Boat Anglers (24%) and Shoreline Anglers (15%). Nearly half of the surveys were obtained at North Bay sites with Shelter Island representing the vast majority of responses (82.7%). Sites in the Mid Bay and South Bay zones provided similar approximately equal levels of the remaining responses. In Mid Bay the Embarcadero Marina Park Pier represented almost half of the responses (46.5%) and in South Bay the majority of responses came from Pepper Park (71.4%).

At least two-thirds of those surveyed indicated their residence was within San Diego County and about three-fourths were from within California.

The most identified ethnicity was White/Caucasian, followed by Hispanic, Asian, Native Hawaiian/Pacific Islander, Black/African American or American Indian (Figure 13). The self-reported ethnicities for San Diego County anglers approximate the general population of San Diego County as indicated by the US Census. Anglers were placed into median household income categories based on their reported ZIP codes and the census information on median household incomes (US Census 2015). The majority of the anglers were from areas that had ZIP codes indicating a median household income between \$24,001 and \$53,000. For 2015, the Federal poverty rate for a family of four was \$24,250. Consumption rates by median household income category, as determined by home ZIP code and US Census data, are approximately the same for those making less than \$50,000 a year but decrease as annual incomes exceed \$50,000 (US Census 2015).

Anglers under 40 consumed fish at a lower level than the total percent of anglers in their age class. Anglers over 40 consumed fish at a slightly higher percentage compared to the overall percent for each age category. Anglers typically prepared and consumed fish fillets (67%) versus preparing/consuming the whole body (33%). The mean consumption rate (18.1 g) was higher than the geometric mean consumption rate (10.6 g) and both were higher than the median (8.5 g). These compare to reported 95% rates of 32 g/day (1 meal per week), in San Francisco Bay, a value which has been used to represent fish consumption statewide (SFEI 2000).

Consumption rates were examined to determine if significant differences were present among socioeconomic categories. Significant differences were found between anglers in the 61-70 and >70 age groups when compared to the younger age groups. Significant differences were also found between anglers who spoke Asian and other languages versus English and Spanish, and differences were found between anglers of different ethnicities. In particular, median consumption rates for Asians were significantly higher than all other ethnicities.

Anglers identified the species of fish they caught and kept for consumption during the previous week. The most common fish consumed was the Pacific Chub Mackerel which was caught slightly less than half of the time (48%). The California Halibut and spotted sand bass were caught and consumed a less than one fifth of the time (18% and 16%, respectively), the Bonito and shortfin corvina at slightly less (12% and 7%, respectively). Other fish species consumed, included several found on the advisory list including: round stingray; barred sand bass; gray smoothhound shark; yellowfin croaker; shovelnose guitarfish; leopard shark; and California lizardfish, each caught between 3% and 6% of the time.

Signs indicating consumption guidance are posted at locations frequented by anglers. Nonetheless, fewer than 50% of all anglers were aware of the consumption advisories. However, anglers who eat the fish had a slightly higher percentage of awareness of the advisories versus those that do not. No differences were found between angler awareness before and after the new signs were put into place and awareness of either the old or new signage did not appear to have a significant impact on consumption behavior.

Of anglers who consume fish they catch, approximately half eat it themselves while one-third share their catch with their families. Almost 70% of the anglers who consume the fish they catch do not share it with children. Of the anglers who share fish with their children (and indicated the portion of fish they ate), almost two thirds consumed fillets and about a third whole bodies.

Overall, consumption rates for anglers catching fish from San Diego Bay are fairly low, and for the majority of anglers, nowhere near the levels indicated by current consumption guidelines. Anglers consuming at rates in excess of guidance are typically middle-aged or older Asian men from socioeconomically disadvantaged communities. This is the single socioeconomic group which appears to indicate a pattern consumption which exceeds the current consumption guidelines.

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## INTRODUCTION

The California Regional Water Quality Control Board, San Diego Region (San Diego Water Board) considers San Diego Bay one of the most important and valuable resources in the southern California Region. The bay provides multiple beneficial uses for both human use and natural services including habitat for fish and wildlife, extensive commercial and industrial economic benefits, and recreational opportunities to residents and visitors. It is imperative to protect its chemical, physical, and biological integrity so the many benefits of San Diego Bay may be enjoyed by future generations.

Three important steps in protecting the beneficial uses associated with ecosystem health and fish consumption are to: 1) measure the bioaccumulation and transfer of these chemical contaminants from sediments and into the food web, from benthic invertebrates, to fish and wildlife and potentially to humans consuming fish from the bay (Bay et al. 2016); 2) assess health risks to humans and wildlife consuming seafood from San Diego Bay; and 3) develop or refine data analysis tools for assessing sediment quality related to bioaccumulation risks. Results will help determine appropriate sediment quality objectives (SQOs) and clean-up levels that are protective of aquatic-dependent wildlife and human health (Shilling et al. 2010).

Prior to this study, there was limited information regarding the actual consumption of finfish from San Diego Bay. The most recent consumption study was conducted over a decade ago (San Diego County Department of Health Services 1990, Environmental Health Coalition 2005) and was relatively limited in spatial and temporal scope, focusing only on anglers fishing from the public piers. This work was commissioned to gain a more comprehensive understanding of fishing activity and consumption than previously available for San Diego Bay. This information may be useful in supporting a future assessment of human health risks associated with consumption of fin fish from the bay, described in step two above. To support such a risk assessment, it is essential to develop a reliable understanding of consumption rates of fish taken from San Diego Bay for cultural, subsistence and recreational use. Additionally, developing a more comprehensive understanding of the specific species and quantities consumed, which portions of the fish are consumed, and how they are prepared are valuable information to fully assessing the health risks associated with consumption.

Assessment of consumption rates was accomplished via field interviews of anglers at common fishing locations (boat landings, piers, and shoreline locations) surrounding San Diego Bay. The study design was developed to account for both geographically and culturally relevant site selection to ensure adequate coverage of all areas of the bay (Southern, Central and Northern). In particular, we sought to differentiate how many anglers are fishing for recreation (anglers practicing catch and release) versus those who keep and consume some portion of their catch. One underlying question we sought to explore was the degree to which consumption may be tied to cultural and/or subsistence use, including subsistence consumption by socioeconomically disadvantaged communities (San Diego County Department of Health Services 1990, Environmental Health Coalition 2005, Shilling et al. 2010, Shilling et al. 2014).

It is important to note that there is no widely accepted definition for subsistence consumption. Definitions generally relate to the method of fishing (using traditional methods, such as hook and line, as opposed to commercial methods) and no definition related to the frequency or amount of fish consumed. Therefore, in context of this study, we define subsistence consumption as an

angler's reported consumption of any portion of their catch for consumption by themselves, their family members or others. When consumption was reported by an angler, this was coupled with additional questions relating to the species consumed, the frequency, quantity, and preparation methods to develop a more comprehensive understanding of consumption behaviors.

## **Background**

In 2014, the San Diego Water Board contracted with the Southern California Coastal Water Research Project (SCCWRP) to perform a fish consumption study in San Diego Bay. The goal of this project was to improve our understanding of contaminant transfer through San Diego Bay food webs to better assess potential risks to humans from consuming contaminated fish taken from the bay. The data collected in this study and subsequently analyzed and presented in this report, provides essential baseline information to assess risk and to inform development of consumption guidelines appropriate for the protection of human health.

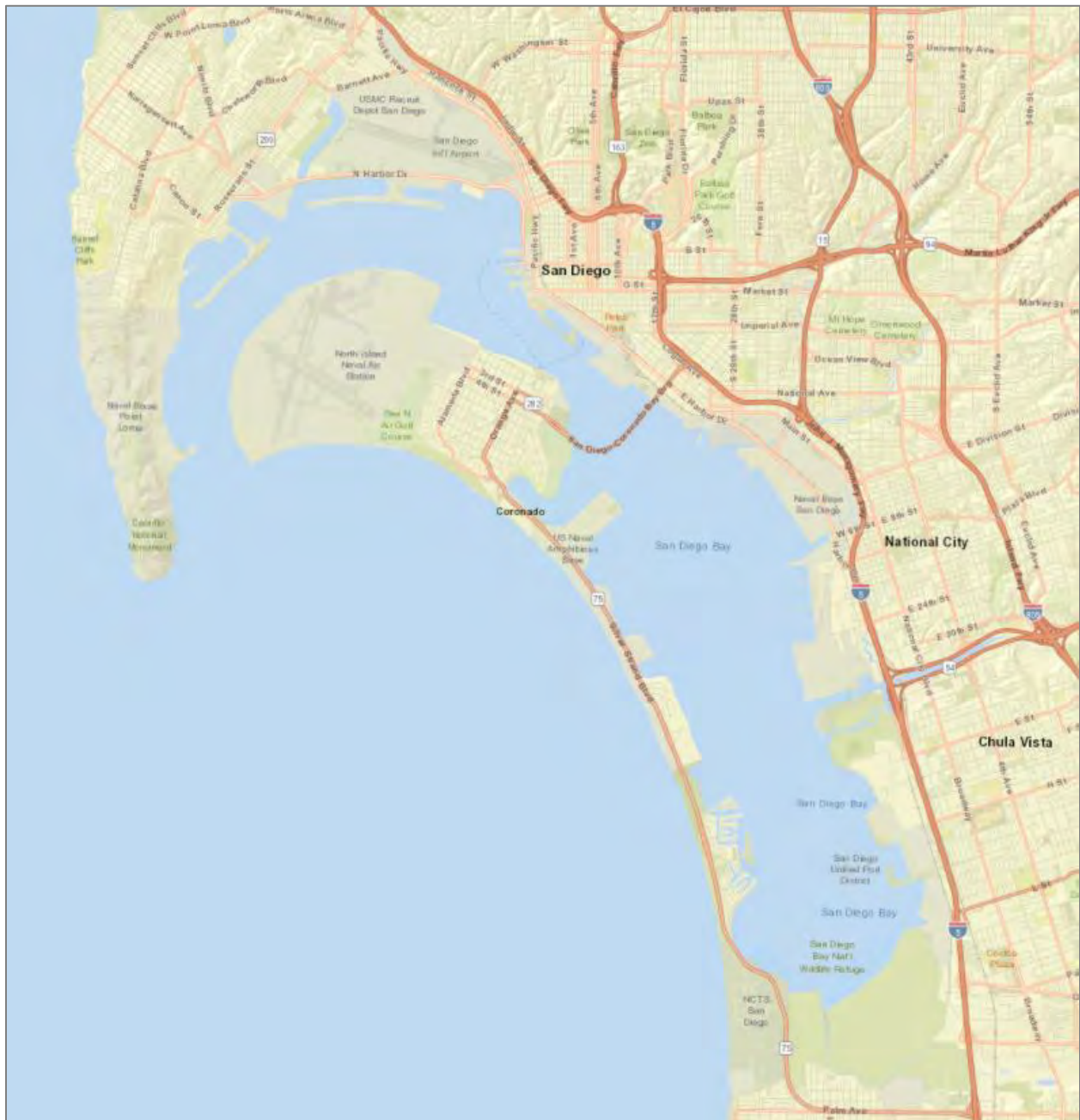
A Technical Advisory Group (TAG, see page iii) for this study was convened in August 2014 to provide guidance and technical support throughout the study. The members of this committee included participants from a wide variety of organizations, including regulators, environmental agencies, and citizen angler groups. All aspects of the study design, sampling scheme, data analyses, and reporting were conducted by SCCWRP with review and input by the Technical Advisory Group (TAG). SCCWRP developed the interview instrument, while maintaining alignment with prior fish consumption studies conducted in California (San Diego County Department of Health Services 1990, SCCWRP 1994, Environmental Health Coalition 2005, SFEI 2000, Shilling et al. 2010, Shilling et al. 2014), to ensure data and results are comparable to the degree feasible. Where appropriate, we included new and/or improved data collection methods and analysis tools to optimize the study design and efficacy, using tablet computers for the accurate and consistent collection and submission of time-stamped and georeferenced survey data collected by the field crews (Steinberg and Steinberg 2011, 2015). Analyses of these data provided an assessment of consumption rates by a variety of sociospatial factors (e.g., where fish are caught, by which demographic and economic groupings, how fish are prepared and consumed and in what quantities) to develop a more detailed assessment of contamination risks for the bay and/or by specific regions of the bay (Steinberg and Steinberg 2009, 2015).

As of July 2015, San Diego County had a population of approximately 3.3 million people (U.S. Census Bureau 2015), with approximately 1.4 million residing within San Diego city limits, making it the eighth-largest city in the United States and second-largest in California. The bay (Figure 1) is a major receiving water body for the San Diego Bay Watershed. The bay is home to one of the five largest ports in California, encompassing 34 miles of waterfront and is home to several major United States Navy and Coast Guard installations, commercial and industrial facilities, and serves as a center for a variety of recreation and tourism activities.

Current and historical activities occurring in the bay include shipbuilding and repair, military bases, defense contractors and manufacturing, historical sewage discharge and stormwater runoff among others. Therefore, the potential for contamination within the bay arises from multiple current and historical sources including various urban and industrial discharges. The California Regional Water Quality Control Board, San Diego Region (San Diego Water Board) is addressing contaminated sediments in San Diego Bay and has identified the following sources of toxic pollutants: urban and storm water runoff, industrial and construction site runoff, shipyards,

shipbuilding industries, naval stations, transportation, oil spills, bilge and ballast water, leaching from creosote pilings, deposits from air, and re-suspension of sediments (RWB-9 2008).

Data has shown contamination of fish tissue in San Diego Bay for decades and the bay was added to the 303(d) list in 2006 for PCB contamination. Recreational and subsistence fishing occurs within the bay from boats, piers and the shoreline. In October of 2013, the Office of Environmental Health Hazard Assessment (OEHHA) with the California Environmental Protection Agency released the Health Advisory and Guidelines for Eating Fish from San Diego Bay (San Diego County) (OEHHA 2013). The guidelines for eating fish from San Diego Bay were based on chemical analysis of fish sampled by two programs, the Coastal Fish Contamination Program (CFCP; Gassel et al. 2002) and the Surface Water Ambient Monitoring Program (SWAMP; Davis et al. 2010). The OEHHA document recommends fish consumption rates for fish caught within the bay (Figure 2) for two consuming populations: 1) women of child bearing age (18-45) and children and; 2) adult males and women over 45. However, at the time of these recommendations, there was not any recent study of fishing activity in the bay providing a current understanding of how many anglers were consuming fish from the bay, and, if so, in what amounts. The OEHHA recommendations on fish consumption for San Diego Bay were based on chemical concentrations in fish tissue, with the concentrations used to determine how much consumers can eat within acceptable exposure levels. Fish consumption advisories are included for fish having been caught within the bay, and for which fish tissue data is specifically available.



**Figure 1. Map of San Diego Bay region.**

Previous consumption surveys have been conducted in San Diego Bay; however, the most recent was conducted over a decade ago (San Diego County Department of Health Services 1990, Environmental Health Coalition 2005). These prior studies were limited in several respects: by the sample size, spatially by sample locations (sampling in specific areas, such as piers) and/or temporally (conducted during a limited time of year, or time of day). One previous study (San Diego County Department of Health Services 1990) was designed to identify the most common fish species caught, the demographics of the anglers, and to characterize their consumption rates. A second study was conducted in 2004 by the Environmental Health Coalition (2005) and was



designed to fill gaps in knowledge of fish consumption patterns for people consuming fish as a subsistence food source. The Environmental Health Coalition study also sought to consider health risks associated with consumption of portions of a fish other than the fillet.

Given a lack of recent studies, the presence of signage relating to consumption guidelines posted around the bay for several years, and potential limitations due to the study designs used, current information regarding fishing and consumption habits of anglers fishing in San Diego Bay and the resulting exposure risks is lacking. Nationally, there is increasing analytical evidence and growing public concern that fish and shellfish caught and consumed by anglers may contain chemical contaminants that pose human health risks (USEPA 1998). To better assess and quantify these risks to the fishing population, information about contaminant levels in fish and actual consumption patterns and preparation techniques must be understood. Several studies have begun to characterize levels of contaminants known to pose health risks in Bay fish (Allen et al. 1996, SCCWRP/MBC 1994, SFEI 1999, SFBRWQCB 1995), but information that describes the consumption patterns of Bay anglers has been sociospatially limited, with focus on select populations and locations (Karras 1998, Ujihara 1997, Wong and Nakatani 1997, Cohen 1995, EHIB 1994, Steinberg and Steinberg 2009).

## **Study Objectives**

The primary goal for this study was to fill in existing data gaps and provide comprehensive information needed to fully assess risk and to inform management decisions for San Diego Bay. Data was collected to aide in understanding current fishing activity, species caught and consumed, preparation methods and sociospatial distributions of the finishing fishing population. Previous OEHHA recommendations were based upon distribution of consumption rates derived from a study conducted in Santa Monica Bay (Allen et al. 1996, SCCWRP/MBC 1994) as default values for California fishing populations when local consumption data are not available (Gassel 1997).

This study was conducted to provide consumption data specifically for San Diego Bay and to provide a basis for developing locally relevant recommendations. Additionally, the findings of this study provide valuable information for improving outreach and education to specific, higher risk segments of the fishing population and for guiding contaminant studies to monitor fish that people consume. In developing this study of fishing activity and consumption in San Diego Bay we focused on three key questions:

1. What are the consumption rates for anglers in San Diego Bay and how do they relate to advisory recommendations?
2. How do socioeconomic differences relate to differences in consumption rates?
3. How do catch and consumption rates vary in space and time by location around the bay and time of year?

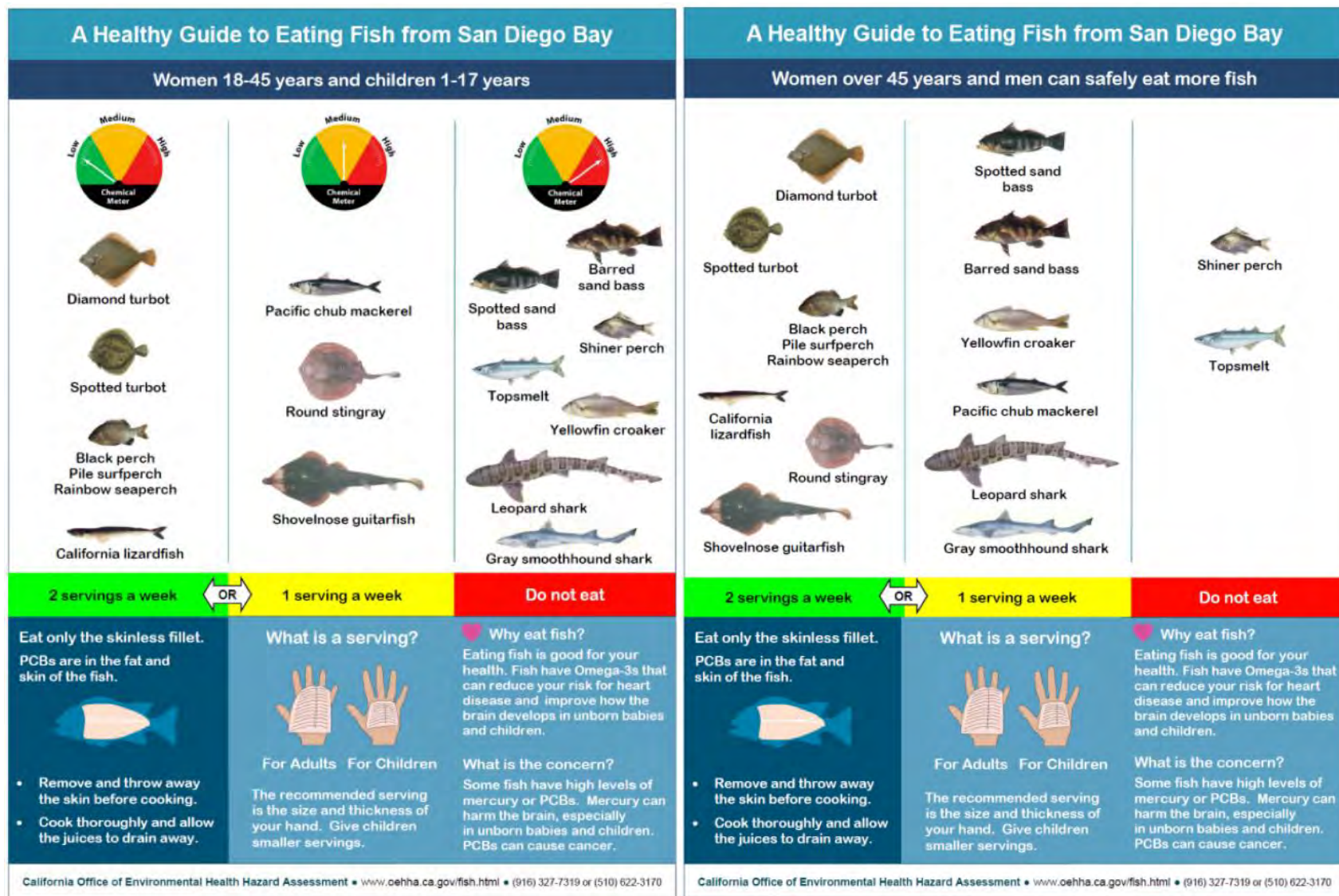


Figure 2. OEHAA fish consumption advisory guidelines for San Diego Bay for Women 18-45 years and children 1-17 years (left) and Women over 45 years and men (right).

## **METHODS**

This study was designed to interview a representative sample of anglers fishing in San Diego Bay over the span of a year from May 1, 2015 through April 30, 2016. When designing the survey and sampling plan, consideration was given to different locations where anglers fish (pier, shoreline and boat), time of day, season and angler's socioeconomic characteristics.

### **Study Design**

In consultation with the TAG, all aspects of the study design, including survey questions, locations, and demographic groups, were discussed to ensure, to the degree feasible, the objectives of the study met the goals of the group and would obtain the most useful information. Committee members also advised SCCWRP about related materials for the study and reviewed all study protocols. Additionally, an environmental sociologist was retained to assist in 1) development of the survey instrument; 2) train field staff on how to effectively conduct interviews; and 3) provide recommendations regarding data analysis. Project staff provided monthly updates to the TAG throughout the study period via progress reports and preliminary data reporting. Committee members also reviewed data analysis methods and drafts of the final report.

Two field interviewers were hired by SCCWRP in April 2015. One multilingual interviewer spoke both English and Vietnamese, and the other had previous experience in interviewing anglers for another project with the California Department of Fish and Wildlife. Orientation and training for interviewers took place in April 2015 and included field safety training by the SCCWRP training officer, and a walk-through of the survey and procedures required to interview anglers. Interviewers practiced administering the questionnaire under the supervision of project managers and sociologist with anglers in Mission Bay to avoid confusion or bias with actual study data which would be collected beginning the following month on San Diego Bay.

The approach was to conduct field interviews of anglers fishing in San Diego Bay and evaluate the consumption rates by a variety of temporal and sociospatial factors, including 1) where and when fish were caught, 2) what key demographic and economic groups were consuming fish from San Diego Bay, and 3) how, and in what quantities were these fish prepared and consumed. For purposes of this study, we optimized field scheduling by dividing the bay into three sampling zones, North Bay, Middle Bay and South Bay which would be easy for the interviewers to visit in a single day (Figure 3).

Stratification of the survey design accounted for the possibility of geographic, temporal and socioeconomic criteria emerging from the data as significant factors in consumption differences. This stratification also facilitated a sample schedule that ensured all areas of the bay would be equally represented in the sampling design. Within each of these regions, areas were further split out by the location from which anglers conduct their fishing: off piers; along the shoreline; or from boats (surveyed at boat ramps/landings) (Figure 4, Figure 5 and Figure 6).

An important aspect of the field sampling strategy was to ensure an adequate sample across different days of the week and times of the day. To accomplish this, the sampling plan was staggered across a full year with a weekly schedule that included all days of the week (Appendix C). In addition, three overlapping six-hour time slots falling between 5:00 a.m. and 9:00 p.m.

were established to account for any variations in fishing activity throughout the day. This schedule was rotated across different days of both weekdays and weekends, recognizing that some species of fish may be caught at different times and days throughout the year. Time slots included 5:00 a.m.-11:00 a.m., 10:00 a.m.-4:00 p.m., and 3:00 p.m.-9:00 p.m. Sampling between 9:00 p.m. and 5:00 a.m. was deemed to present unnecessary risk to the field team and not considered. Nonetheless, fishing activity does occur during these hours and is not represented in the findings of this study.

Locations for the initiation of each survey period were staggered by different fishing areas, (pier, shoreline, and boat ramps) to ensure consistent representation of all areas. Interviews with pier and shoreline anglers were generally easier to accomplish since they tended to be located at a specific location for a long period and could be approached one by one to respond to the survey. By contrast, boat anglers enter the bay via a limited number of public launches and are only accessible for the brief time that they are entering or leaving the water, and only so long as they were willing to be interviewed while unloading or loading their boat. Kayak fishing is another popular means of fishing in the bay. These anglers may access the bay at launch ramps, or at other shoreline locations. Results from kayak anglers were considered in conjunction with other boat-based anglers in the study.

Access to boat anglers was more difficult and resulted in a lower number of responses relative to pier and shoreline anglers, however, given the survey design and number of responses from boat-based anglers, we believe the sampled population of boat anglers, while potentially under-reporting overall fishing activity relative to other modes, is representative of consumption behavior of the boat based anglers. Nonetheless, these constraints should be taken into consideration when reviewing the results.

Trained interviewers using a predetermined set of questions conducted the survey. Interviewee responses were entered on the spot using a custom mobile “Fish Consumption Survey” application, developed specifically for this study by SCCWRP, for Android tablets. Survey results were uploaded directly to a database housed at SCCWRP at the conclusion of each survey day. The database was designed to parse and organize survey data upon receipt to optimize survey data management and analysis. Additional materials including fish photos (Appendix B) to assist respondents in identifying species caught and consumed, silicon fish fillet model to assist respondents in identifying the size of a serving consumed, and written copies of the survey with addressed/stamped envelopes for respondents who were unable to finish the full survey in the field). These artifacts ensured field interviewers would obtain consistent, high quality data across survey staff and throughout the study period. A field survey schedule was developed to ensure proper deployment of field crews throughout the survey period (Appendix C).





North Bay	Includes one pier and boat ramp (Shelter Island/Shoreline Park), and shoreline access via Harbor Island Park, Liberty Station NTC Park and along Harbor Drive north of downtown San Diego.
Mid Bay	Includes two piers (Coronado Ferry Landing, Embarcadero Marina Park), shoreline sites (Tidelands Park, Glorietta Bay Park & Embarcadero Marina Park), one boat ramp and rental boats (Glorietta Bay).
South Bay	Includes one pier, shoreline sites & two boat ramps (Chula Vista Bayfront Park/Bayside Park and Pepper Park).

**Figure 3. Aerial image of San Diego Bay. Survey zones in the north, middle and south bay regions are indicated by the colored boxes.**

## North Bay Sites



Figure 4. Map of North San Diego Bay area. Area (A) is Shelter Island and (B) Harbor Island and NTC Park/Marine Channel, and (C) North Harbor Drive. [Site detail maps are provided in Appendix A].



## Mid Bay Sites



Figure 5. Map of Mid San Diego Bay area. Area (A) is Coronado/Glorietta Bay Park, (B) Coronado Tidelands Park, (C) Coronado Ferry Landing Pier, (D) Embarcadero Marina Park Pier, and (E) Cesar Chavez Park. [Site detail maps are provided in Appendix A].

## South Bay Sites



Figure 6. Map of South San Diego Bay area. Area (A) is Pepper Park and (B) is Bayside Park/Chula Vista Bayfront Park [Site detail maps are provided in Appendix A].



Early in our project planning, we learned that the Port of San Diego intended to post new Fish Consumption Warning Signs in early June 2015 at piers and boat ramps around San Diego Bay (Figure 7). To identify any potential biases caused by the new signs, we added extra sampling days (Appendix C) during the initial month of the field surveys (May 2015) to capture sufficient data to represent fishing activity under the old signs.



Figure 7. Posted advisory warnings before (left) and after (right) June 1, 2015.

## Survey Design

The survey questionnaire was designed to gather information needed to address the objectives listed in Section I. The survey includes questions on ethnicity, age, fishing frequency, amount of fish eaten, types of fish eaten, preparation and cooking methods, others in the household who eat fish caught, and awareness and knowledge of the state health advisory (See Appendix D for a copy of the questionnaire). Trained interviewers administered the questionnaire to anglers at sites around the bay according to the survey schedule. To facilitate consistent data throughout the study, most questions were designed using a closed-end question format, with discrete response categories. Some questions included an “other” category where appropriate to allow for a write-in response. We reviewed survey questions and methods used in prior consumption studies conducted in California (San Diego County Department of Health Services 1990, SCCWRP/MBC 1994, Environmental Health Coalition 2005, SFEI 2000, Shilling et al. 2010, Shilling et al. 2014, EHIB 1994 and OEHHA 1994) to ensure data comparability wherever possible. Additional questions were included to capture sociospatial data which could be later correlated with existing GIS-based data to enhance the socioeconomic information for the study.

Initial drafts of the survey were reviewed by the TAG and beta tested during the field crew training in April 2015 to ensure clarity and completeness. Revisions primarily served to improve clarity of questions, minimize response biases, maximize recall, and reduce interview time. Final

questions were implemented in a custom Android application running on Samsung Galaxy Tablets, and assigned unique identification numbers for each response.

Anglers were approached and given the choice to participate in the survey. If an angler was willing, the interviewer asked the full set of survey questions and recorded the answers on an Android tablet. For anglers who refused to complete the survey, their fishing activity was recorded in the database with a date, time, and location to measure of total fishing activity in the bay. When an angler was approached, our interviewer spent a moment chatting with them to build rapport. They then provided the angler with a brief description of the study and invited their participation. Five pre-survey questions (see below) were asked.

### **PRESURVEY QUESTIONS**

1. Initiate Survey Choose type of Angler (Pier, Shoreline or Boat) – this will automatically capture the date, time, and location.
2. Have you ever been surveyed before for our San Diego Bay fish consumption study?  
Yes                      No

IF YES: How long ago did you do the survey?

- A)              This month [END SURVEY]
- B)              Within the last 3 months [Continue Survey]
- C)              Within the last 6 months [Continue Survey]
- D)              More than 6 months ago [Continue Survey]
- E)              Not Applicable [Continue Survey]

**BOAT ANGLERS ONLY:** Did you fish or are you fishing in San Diego Bay?

Yes              [Continue Survey]

No              [END SURVEY]

3. What is your zip code?
4. Do you, family or friends eat the fish that you catch from San Diego Bay?  
Yes                      No
5. Would you be willing to complete a survey right now?  
Yes                      No

Respondents willing to complete the full survey were asked 21 additional questions (Appendix B). If they were unable to finish the remaining questions on site, or at any point during the remaining survey, they were offered a paper copy to fill out and mail back. Paper surveys were coded with a survey number to be correlated to responses recorded on the Android tablet in the field. Respondents unwilling to respond to additional questions were thanked by the interviewer, and answers to any of the five introductory questions retained for analysis. If questions

pertaining to the study or study results came up, the interviewer provided additional information via a business card (Figure 8) if the angler wished to follow up. The specific sample size (N) varied by question either due to a respondent failing to answer all of the required questions or where the answer provided was excluded as an outlier.



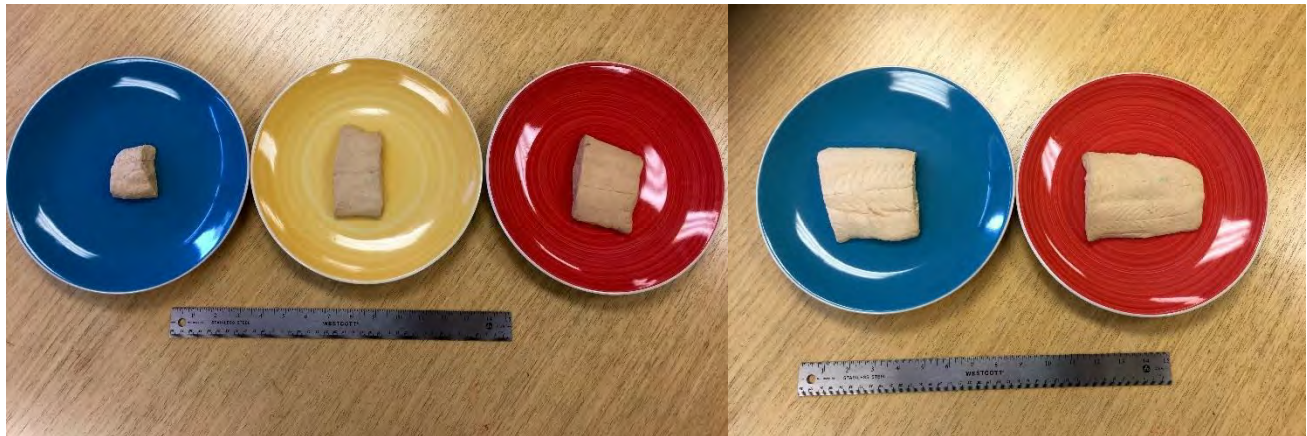
**Figure 8. Information card given to the anglers to provide a means to find out more about the study and its results.**

To identify specific species caught and consumed, interviewers showed survey respondents photo cards with color pictures of 30 species of fish commonly caught in the bay (Appendix B). High quality photos were obtained from the internet and showed defining characteristics. Fish species included on the photo card were recommended by San Diego Water Board staff and TAG members as both important, and likely to be caught, in San Diego Bay. Consumption practices for the California halibut, shiner perch, spotted sand bass, striped mullet, topsmelt, and white croaker were of particular interest due to a concurrent bioaccumulation (Bay et al. 2016) study in San Diego Bay for the same species.

During the survey respondents were asked to identify the portion size taken from their catch and consumed as a typical meal. To assist the respondents in determining the portion size consumed by themselves, their family or friends, physical fish fillet models were shown to the anglers (Figure 9). The fillet models represented five portion sizes: 1.5, 3.0, 4.5, 6.0, and 7.5 ounces.

The field interviewers were directed to inform the respondents that they could choose any individual or combination of fillet models to add up to the portion they ate which best matched the portion they typically ate in a single meal (they were not asked to choose a range of filets they might eat nor were they asked to indicate how much they ate on average). In addition to the fillet model sizes, mail-in respondents were given a choice of other to indicate how much (in ounces) they typically ate in a meal. The survey instrument and fish fillet models used were based on a common approach co-developed by EHIB (Environmental Health Investigations Branch), University of California, Davis, OEHHA, and CDFW in 2003 to facilitate the direct comparison of this study with other regional surveys in California.

Anglers were asked to recall if they ever ate fish from San Diego Bay, and if so, general questions about the portion of the fish eaten and preparation methods used were asked in the follow-up survey. When asking respondents for specific details about the types of fish caught and consumed, answers were limited to only the previous week to minimize recall problems. Additionally, respondents were asked to recall the total number of meals consumed by them or their families from fish caught in the bay in the last 30 days. A recall of 30 days is thought to be the maximum length of time for reliable recall, and the vast majority of comparable studies, have reported accurate findings using this approach among a wide range of people (Villegas et al. 2007, Quandt et al. 2007, Sullivan et al. 2006, Kuster et al. 2006, McNaughton et al. 2005, Shilling et al. 2010, Shilling et al. 2014).



**Figure 9. Fish fillet models from smallest to largest (1.5 oz., 3.0 oz., 4.5 oz., 6 oz., 7.5 oz.) as viewed on standard 10-inch dinner plates.**

## **Data Management and Analysis**

### **Data Collection**

Most field survey responses were captured by the interviewer with a mobile application on an Android tablet. These data were uploaded on a nightly basis to a database located on a server at SCCWRP. Each interviewer was responsible for transferring their own data. Reviews of the data occurred periodically throughout the study to ensure that all data were being collected properly. As data were submitted from the field it was captured into a MySQL database on a server housed at SCCWRP. Data submitted via mail were entered into the project database at SCCWRP upon receipt and joined to the appropriate field data record associated with the mailed responses. These data were subsequently transferred to a Microsoft Access database for data formatting and preliminary analysis. Data analysis was done using SigmaPlot 11 (Systat Software, San Jose, CA) and the R Statistical Package (R Development Core Team 2016).

Additional supporting socioeconomic data were obtained through State and Federal agencies and tied to the survey responses based on geospatial parameters collected in the field, including the respondent's home ZIP code and name of their hometown. These supplemental data provided a means to include additional supporting population level information regarding the demographic and socioeconomic characteristics of the communities from which the anglers come.

## Data Quality Assurance and Quality Control

Multiple Data Quality Assurance and Quality Control (QA/QC) measures were incorporated into both the mobile application and the receiving database. Wherever feasible, the system was designed to prevent errors in data entry. In some instances, fields were automatically populated using system information, for example date, time and GPS location of the interview. The majority of GPS locations recorded fell within a few meters of the actual location; however, a small percentage of locations, particularly at the beginning of a survey session when the tablet was powered on, the GPS signal was less accurate, as the device was still obtaining a satellite signal. Due to GPS error, some mapped points fall in incorrect locations, but could still be allocated to the proper survey site based on the survey schedule and timestamp.

Responses to the interview were recorded in the mobile application using pick-lists and drop-down menus from which only valid responses could be selected, ensuring higher data quality than recoding answers by hand and entering them at a later time. For those questions that permitted open-ended responses, fields were configured to minimize data coding errors by requiring answers to be entered using the correct format. Similarly, when data was submitted to the back-end database at SCCWRP at the conclusion of each sampling day it was further checked for any QA/QC issues. No original data was altered on submission, but rather was flagged for further review and normalized for consistency as needed prior to analysis.

QA procedures put into place prior to data collection consisted of:

- Obtaining review and input on all study materials and protocols by San Diego Bay Fish Consumption Study TAG members
- Field testing of survey instrument
- Thorough training of interviewers in all aspects of survey administration
- Incorporating visual cues and tools to maximize recall during the interview
- Review of mobile application and backend database to ensure data integrity

QC measures undertaken throughout the data collection phase consisted of:

- Audits of interviewing activities by the field coordinator throughout the study as data were submitted to the data system.
- Regular verbal and written feedback to interviewers individually as needed
- Scheduled group meetings to provide periodic updates and to review procedures
- Inclusion of redundant questions worded differently to check consistency of answers
- Use of lookup lists and data business rules to ensure consistency in data collection

## Data Analysis

Summary data analysis occurred on a monthly basis throughout the study to monitor progress. An R-script was developed to automatically produce the monthly reports which were shared with the contract manager and TAG members. The full data analysis was conducted following completion of all field work, and considered additional input from TAG members and the contracted social scientist. The specific sample size (N) used in the data analysis varied on a



question by question basis either due to a respondent failing to answer all of the required questions or where the answer provided was excluded as an outlier.

To calculate measures of central tendency for consumption rates, medians (50<sup>th</sup> percentile), 90<sup>th</sup>, 95<sup>th</sup>, and 99<sup>th</sup> percentiles, and geometric and arithmetic means were used (USEPA 2014, Sokal and Rohlf 1981). Unless noted otherwise, all means listed in tables, figures and the text are arithmetic means. The arithmetic mean was calculated using the following formula:

$$\text{Arithmetic Mean} = \frac{1}{n} * \sum_{i=1}^n x_i$$

n = the number of terms (e.g., the number of items or numbers being averaged)

$x_i$  = the value of each individual item in the list of numbers being averaged

The geometric mean was calculated using the following formulas:

$$\text{Geometric Mean} = \sqrt[n]{x_1 \bullet x_2 \bullet x_3 \bullet \dots \bullet x_n}$$

or its equivalency:

$$\text{Geometric Mean} = e^{\left( \frac{\sum_{i=1}^n \ln x_i}{n} \right)}$$

The logarithmic transformation used in computing the geometric mean, a common transformation in biological and medical applications (Armitage and Berry 1987), was used to produce a more normal distribution (SFEI 2000).

## Ethnicity

Respondents were prompted to categorize themselves when asked about their ethnicity. Ethnicities were then categorized for analysis to match as closely as possible the United State Census Bureau's categories. In some cases, respondents identified as more than one ethnicity. These respondents were categorized in this study by their secondarily identified ethnicity. For example, if someone identified themselves as Black/African American and Hispanic, they were listed in this study as Hispanic. This was done both to ensure that all ethnicities were represented and counted in amounts that allowed for more statistically powerful results, even if they were not

identified as the primary ethnicity. In some cases, too few respondents fell into a reported ethnicity with a sample size sufficient to be assessed. In these cases, the responses were grouped with the most appropriate alternative group, for example, Middle Eastern and European ethnicities were grouped as Caucasian for this study. For presenting information on ethnic groups, we refer to the following major ethnic groups: *Black/African American, Latino/Hispanic, Caucasian, Asian, American Indian, and Native Hawaiian*.

### Avidity Bias

Avidity bias (also known as response bias) here is defined as the frequency at which anglers go fishing so as to add bias to the results. Fishing frequency may vary for some anglers by days, weeks, months or years. Those who fish daily, weekly, or even monthly may be surveyed more often and add bias to the results through having been overrepresented. At the opposite end, those who fish infrequently could be underrepresented. In on-site surveys, such as this study, how often an angler goes fishing determines how likely he will be approached for an interview. Avidity bias has been described by many authors (ATES/OEHHA 2000, Ossiander 1999, USEPA 1997, Pollock 1994, Price 1994, Thomson 1991) and most recently a description has been included in the USEPA's Guidance for Conducting Fish Consumption Surveys (USEPA 2016). Avidity bias occurs when a correlation exists between important parameters for determining things such as consumption rate. Some studies correct for this bias by weighting the respondents in proportion to the inverse of their sampling probability, which is done commonly for survey sampling (Stuart et al. 1976, Snedecor and Cochran 1989). For this study, we did not weight respondents for avidity. Avidity was not considered in our analysis due to a small number of survey responses in this category. When our interviewers approached an individual to be surveyed they were asked if they had been interviewed previously. If the respondent had been interviewed within the previous month they were not re-interviewed. However, if they had been interviewed more than a month prior they were re-interviewed and their results were analyzed separately.

## RESULTS

The results provided in the following section summarize the study data and provide an overview of key findings relating to the major study objectives. The full data set used for analysis is available at: <http://www.sccwrp.org/fishconsumption/data.html>. Terminology used in this report was selected for consistency with previously published fish consumption studies and the recently released EPA document “Guidance for Conducting Fish Consumption Surveys” (USEPA 2016).

### Sampling Success

We approached a total of 1549 anglers in San Diego Bay (Table 1). Overall, Pier Anglers were approached most often (62%), followed by Boat Anglers (24%) and Shoreline Anglers (15%). Shoreline Anglers and Pier Anglers were the most likely to complete a survey (89% and 74%, respectively), while Boat Anglers completed surveys less than half the time (48%).

**Table 1. Number of Approached Anglers and Completed Surveys by Angler Type.**

Approached Anglers			Complete Surveys*			
Type of Angler	Count	%	Type of Angler	Count	%	% Completed
Pier Angler	952	61	Pier Angler	706	65	74
Boat Angler	367	24	Boat Angler	175	16	48
Shoreline Angler	230	15	Shoreline Angler	205	19	89
Total	1549	100	Total	1086	100	70

\* The specific sample size (N) varied by question either due to a respondent failing to answer all of the required questions or where the answer provided was excluded as an outlier.

Surveys were conducted throughout a full calendar year between May 1, 2015 and April 30, 2016 using a multi-variate sampling schedule to account for both space and time. The sample schedule specifically accounted for the location where fishing occurred, region of the bay, time of day, time of week and season of the year (



Table 2). Of those approached, 81% (1255) were first time interviews, with the remainder being re-interview attempts. Of the 17% of first time interviewees who did not complete the survey, 11% (all boaters) did not complete an interview because they took their boat outside of San Diego Bay into open water, 5% declined to be interviewed, and 1% stopped the interview before it was finished. For purposes of this study only anglers fishing within the confines of San Diego Bay were interviewed.

**Table 2. Sampling effort split out by geography, time of day, week day and season.**

<b>Category</b>	<b>Count</b>	<b>Percent</b>
Bay Region		
North	728	47
Middle	427	28
South	394	25
Time of Day		
Morning	535	35
Midday	597	39
Evening	417	27
Week Day		
Monday	131	8
Tuesday	105	7
Wednesday	140	9
Thursday	129	8
Friday	376	24
Saturday	431	28
Sunday	237	15
Season		
Spring	684	44
Summer	347	22
Fall	301	19
Winter	217	14
Total for each:	1549	100

Sampling success varied by sites within each sampling zone. Nearly half of the surveys were completed at North Bay sites with Shelter Island representing the vast majority of responses (82.6%). Sites in the Mid Bay and South Bay zones provided similar approximately equal levels of the remaining responses. In Mid Bay the Embarcadero Marina Park Pier represented almost half of the responses (46.5%) and in South Bay the majority of responses came from Pepper Park (71.4%). Table 3 provides a complete list of response rates for each sampling zone and the sites visited within them.

**Table 3. Sampling effort split out by sampling zone and site within each of the bay regions.**

Location	Count	Zone %	Overall Percent
<b>North Bay</b>			
Shelter Island	601	82.6	39
Harbor Island	124	17.0	8
NTC Park/Marine Channel	1	0.1	0
North Harbor Drive	2	0.3	0
<b>TOTAL</b>	<b>728</b>		<b>47</b>
<b>Mid Bay</b>			
Coronado/Glorietta Bay Park	52	12.2	3
Coronado Tidelands Park	11	2.6	1
Coronado Ferry Landing Pier	159	37.3	10
Embarcadero Marina Park Pier	198	46.5	13
Cesar Chavez Park	6	1.4	0
<b>TOTAL</b>	<b>426</b>		<b>27</b>
<b>South Bay</b>			
Pepper Park	278	71.4	18
Bayside Park	111	28.5	7
<b>TOTAL</b>	<b>389</b>		<b>25</b>
Unknown	6		1
Total	1549		100

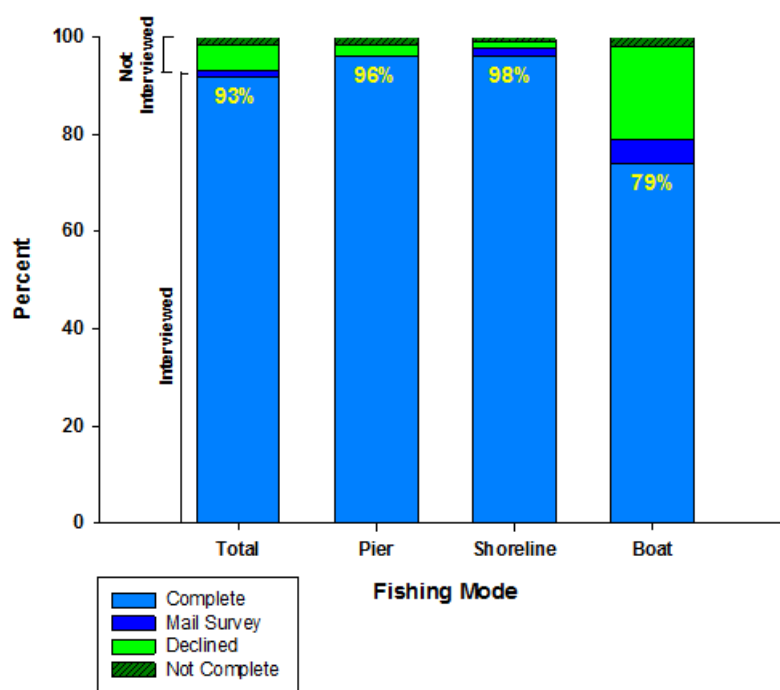
There were 294 interview attempts of people who had been previously approached. Of these, the majority (243) had been approached within the previous month, and as stipulated in the study plan were not re-interviewed. Few anglers (7) eligible to be re-interviewed elected not to be respond to an additional survey. Overall, a total of 44 people previously surveyed more than three months prior were re-interviewed. Given the very small number of anglers that had been previously interviewed, we excluded their responses from subsequent analysis to avoid avidity bias. A summary of sampling success is provided in Table 4.

The overall success rate for surveying first time interviewees was 93% (Figure 10). Shoreline Anglers, present in smaller numbers, were approached the least often, but when they were, this group had the highest rate of successful interviews (98%). Boaters were the second most approached angler type but resulted in the lowest success rate at just under half (79%). Pier Anglers were the most commonly approached and agreed to be interviewed 96% of the time. Both boat and Shoreline Anglers returned mail-in surveys; however, the majority of mail-in surveys were sent in by Boat Anglers. When anglers were fishing in a group, the interviewer attempted to gather a separate survey from each individual.

**Table 4. Sampling success by interview category.**

Interview Category	Total N	Angler Type						
		Pier		Shoreline		Boat		
		N	% Total	N	% Total	N	% Total	
Initial Interview Attempts								
Complete	1030	669	65.0	199	19.3	162	15.7	
Mail Survey	14	0	0.0	3	21.4	11	78.6	
Total Complete	1044	669	64.1	202	19.3	173	16.6	
Declined	61	16	26.2	3	4.9	42	68.9	
Do Not Fish in SDB	133	0	0.0	0	0.0	133	100.0	
Not Complete	17	11	64.7	2	11.8	4	23.5	
Total Not Complete	211	27	12.8	5	2.4	179	84.8	
Total	1255	696	55.5	207	16.5	352	28.0	
Secondary Interview Attempts								
Complete								
Within Last 3 Months	24	23	95.8	1	5.0	0	0.0	
Within Last 6 Months	19	15	78.9	2	10.0	2	16.7	
Within Last 6+ Months	1	0	0.0	0	0.0	1	8.3	
Total Complete	44	38	86.4	3	6.8	3	6.8	
Not Complete								
Within Last Month*	243	212	87.2	20	100.0	11	91.7	
Within Last 3 Months	6	5	83.3	0	0.0	1	8.3	
Within Last 6 Months	1	1	100.0	0	0.0	0	0.0	
Total Not Complete	250	218	87.2	20	8.0	12	4.8	
Total	294	256	87.1	23	7.8	15	5.1	
Total Interview Attempts	1549	952	61.5	230	14.8	367	23.7	

\* Those interviewed within the last month were not reinterviewed.



**Figure 10. Percent of anglers interviewed and not interviewed by location of fishing activity. Boaters not fishing in the bay were excluded. Complete and Mail Surveys were considered "interviewed" and Not Complete and Declined were "not interviewed". N = 1549**

## Angler Characteristics

One of our goals for this study was to determine what type of person fishes in, and consumes fish from, San Diego Bay, in what quantities, and if so, if this is at a level in excess of levels indicated by current consumption guidelines. In the following sections, we present our survey results as they pertain to angler demographics, ethnicities, and ages for both the angler community in general and specifically, for those anglers who are consumers of San Diego Bay fish. We explored behaviors regarding how often and how much consumers and household members have been eating Bay fish, what portion of the fish is consumed and the preparation methods used. We also examined these data for any seasonal differences in fishing and consumption behavior. Any anglers approached who indicated that did not catch fish within the confines San Diego Bay (boaters) were excluded from our analysis.

### Where do anglers come from?

At least two-thirds of those surveyed indicated their residence was within San Diego County and about three-fourths were from within the state of California (Table 5). Approximately one quarter of interviewees did not provide adequate information on their residence. Only about 1% of the respondents were from out of state with most coming from nearby states, primarily from Arizona (0.6%). All anglers were from the western United States with those coming from Oregon and Colorado traveling the farthest (Figure 11). Respondents listed as having an unknown place of residence were either those who declined being interviewed or those who had

been interviewed within the last month. These anglers were recorded as an indication of fishing activity but not included in the analysis.

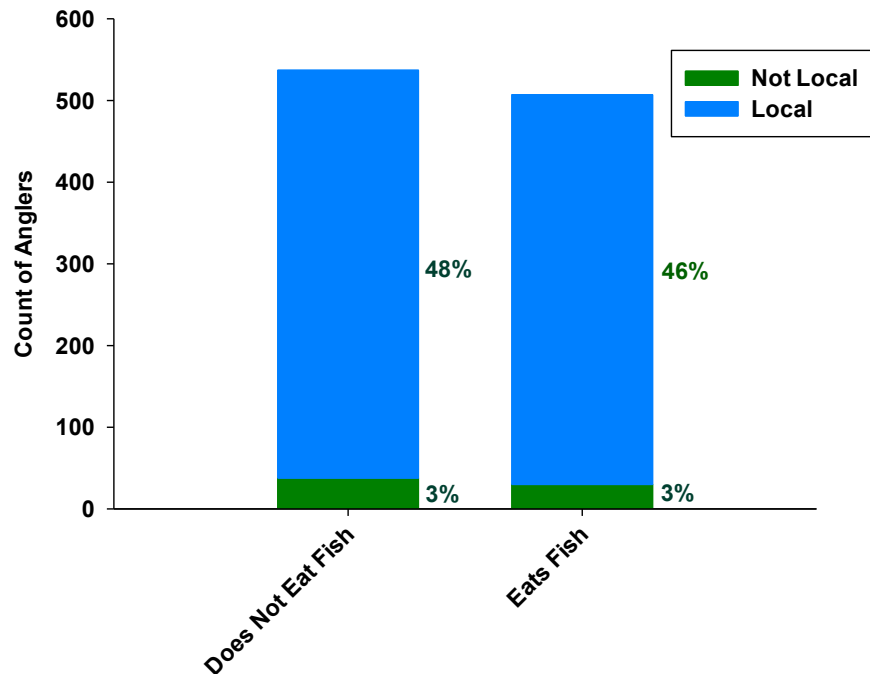
**Table 5. Breakdown of where anglers identified they lived by county (if in California) or state (outside of California).**

County	Count	Percent	State	Count	Percent
Within California			Other States		
San-Diego County	1093	70.6	Arizona	10	0.6
Riverside County	21	1.4	Colorado	2	0.1
Los Angeles County	11	0.7	Nevada	2	0.1
Orange County	8	0.5	New Mexico	1	0.1
San Bernardino County	7	0.5	Texas	1	0.1
Monterey County	5	0.3	Utah	1	0.1
Kern County	1	0.1	Oregon	1	0.1
Alameda County	1	0.1	Total Out of State	18	1.2
Placer County	1	0.1			
Yolo County	1	0.1	Unknown	380	24.5
Sacramento County	1	0.1			
San Mateo County	1	0.1	Overall Total	1549	100.0
Total Within State	1151	74.3			

Of all those completing the survey, just over half (51%) do not eat fish, most of which consisted of San Diego county residents (48% of those surveyed), with 3% coming from outside the county. Similarly, of those surveyed, the vast majority of anglers who eat fish, 46% lived within San Diego County, with 3% coming from elsewhere. (Figure 12).



**Figure 11: Map of where anglers identified as living (purple dots). Most anglers came from Southern California, with additional clusters from areas near central California and the San Francisco Bay region and the Southwest states. N = 1549**

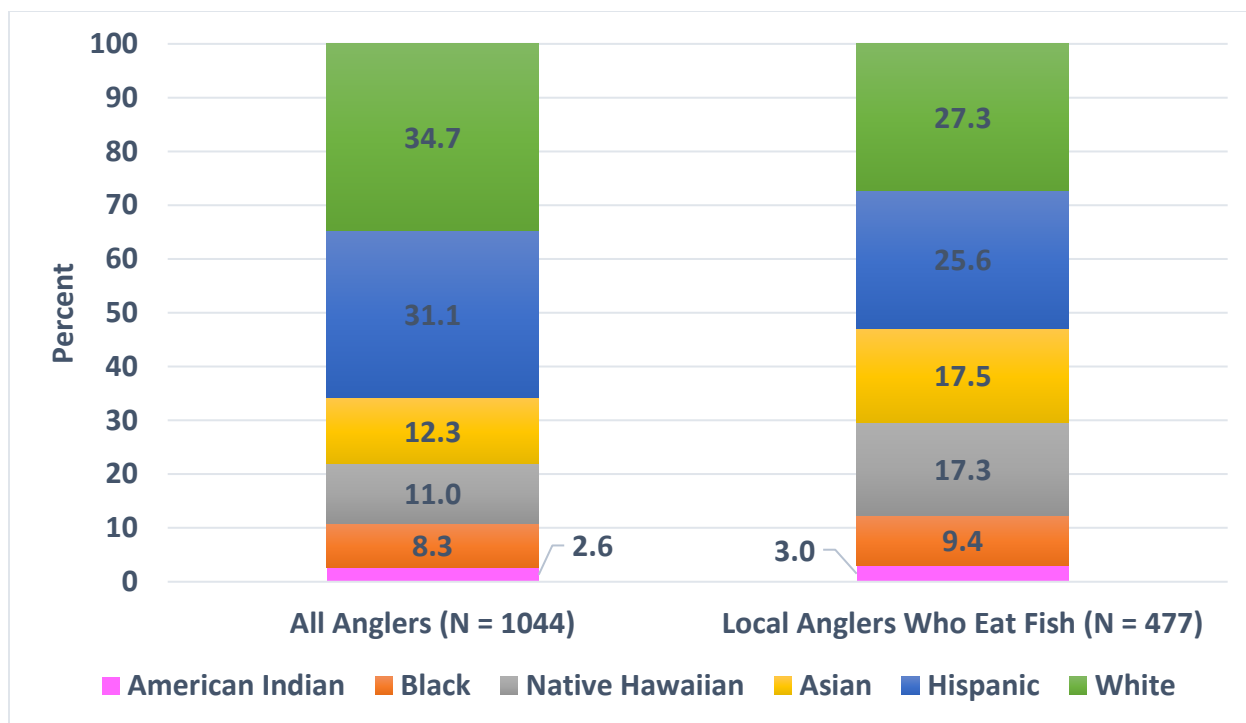


**Figure 12. Angler responses to the question: “Do you, family or friends eat fish that you catch from San Diego Bay?” broken out by percent of those living locally (within San Diego County) and non-locally who stated they do or do not eat the fish. N = 1044**

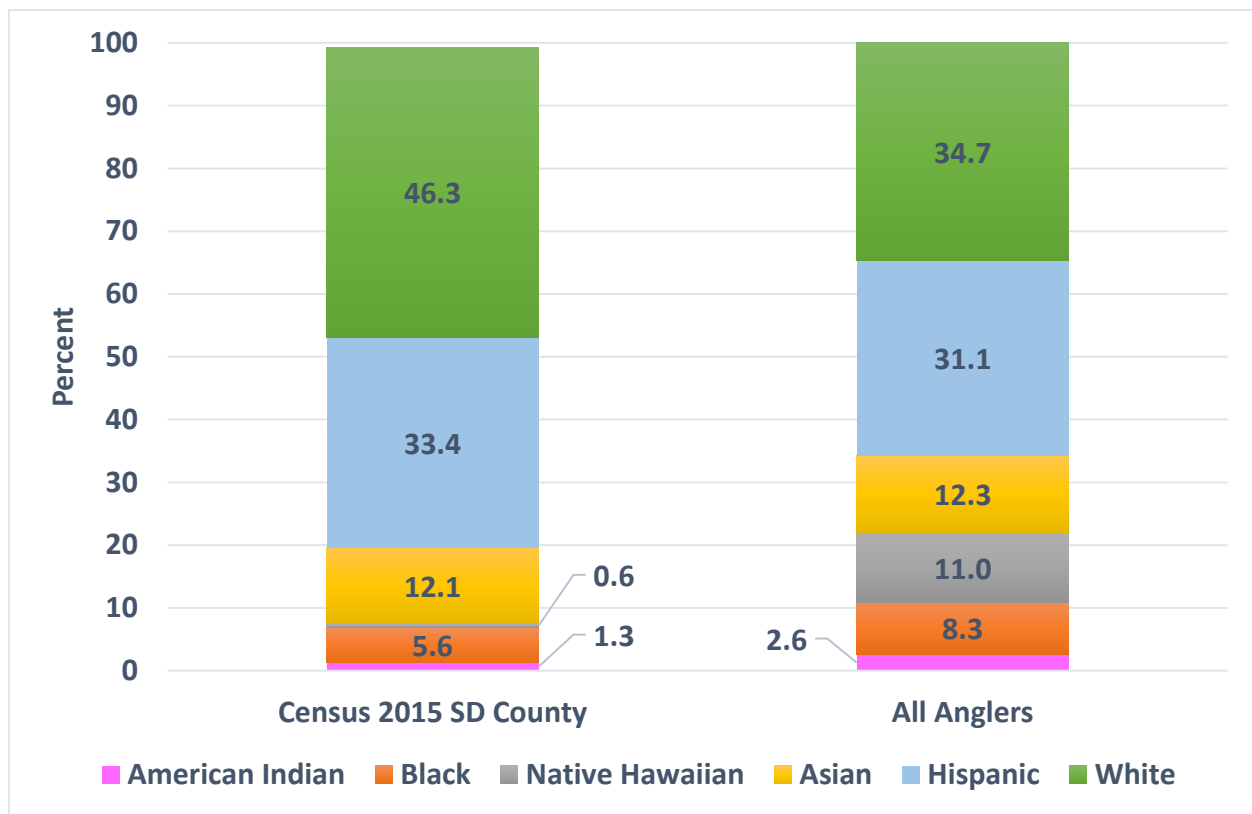
### Ethnicity

Anglers were asked to self-identify their ethnicity. The most identified ethnicity was White/Caucasian, followed by Hispanic, Asian, Native Hawaiian/Pacific Islander, Black/African American or American Indian (Figure 13). The self-reported ethnicities for San Diego County anglers approximate the general population of San Diego County as indicated by the US Census with sizable under-representations of White and, to a lesser degree, Hispanic anglers, and over-representations of Black, Native America and particularly, Pacific Islander populations. Asians anglers were present at levels similar to the general population (Figure 14).





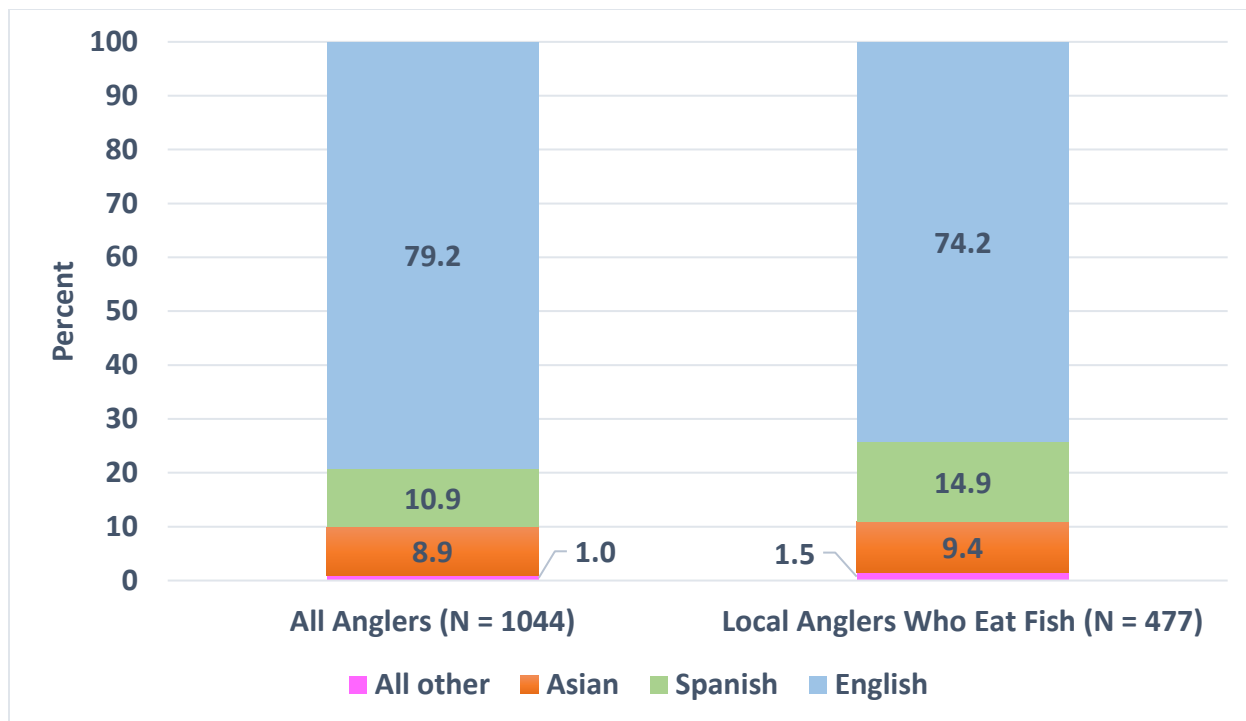
**Figure 13. Self-reported ethnicity of anglers interviewed broken down by all anglers in San Diego Bay and those who eat fish from San Diego Bay. N = 477; including five anglers under the age of 18.**



**Figure 14. A comparison of response rates from the San Diego angler population compared to the representation of ethnicities in the general population of San Diego County. N = 1044**

### Language

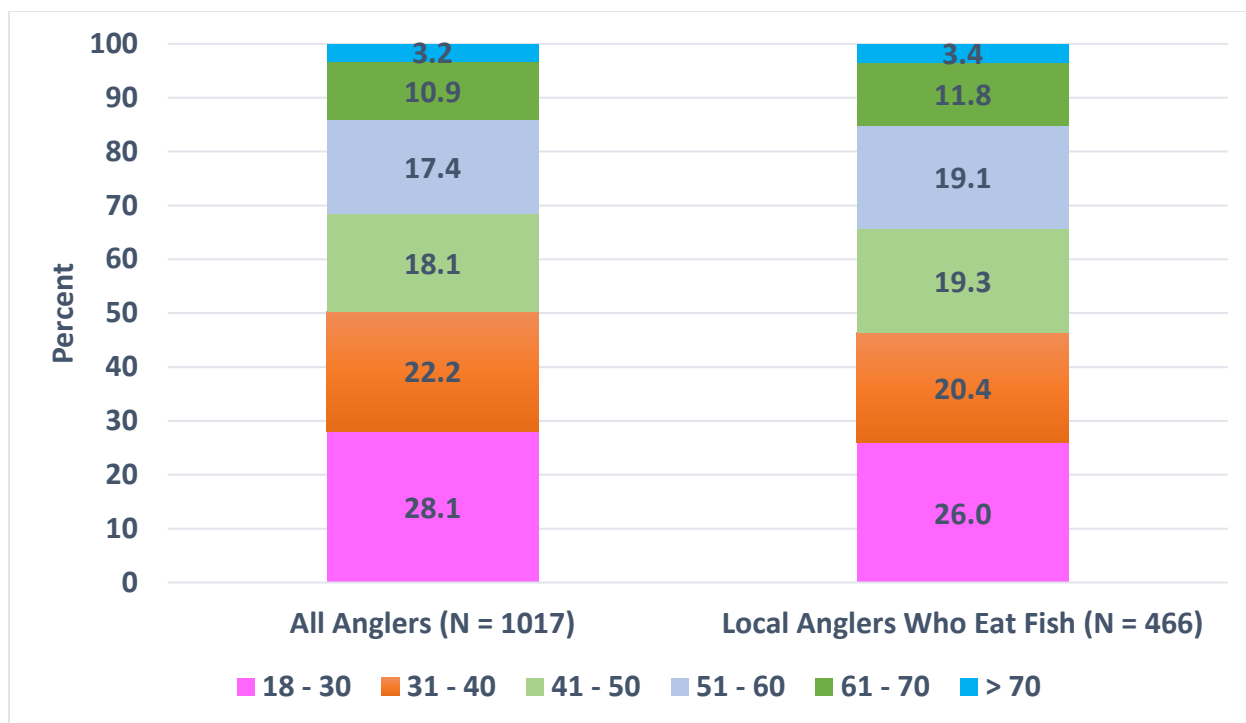
Anglers were asked to identify the primary language spoken at home. The majority of all anglers and anglers who eat this fish indicated they spoke English as their primary language (>70% for both). Spanish and Asian languages were the next most common languages spoken but with far lesser frequency (< 20%). A very negligible number of respondents spoke any other language at home (grouped together) and were not high in number at all (Figure 15).



**Figure 15. Percent of anglers who spoke different languages by those that eat fish and are local versus all anglers. N = 477; includes five local anglers under the age of 18.**

### Age

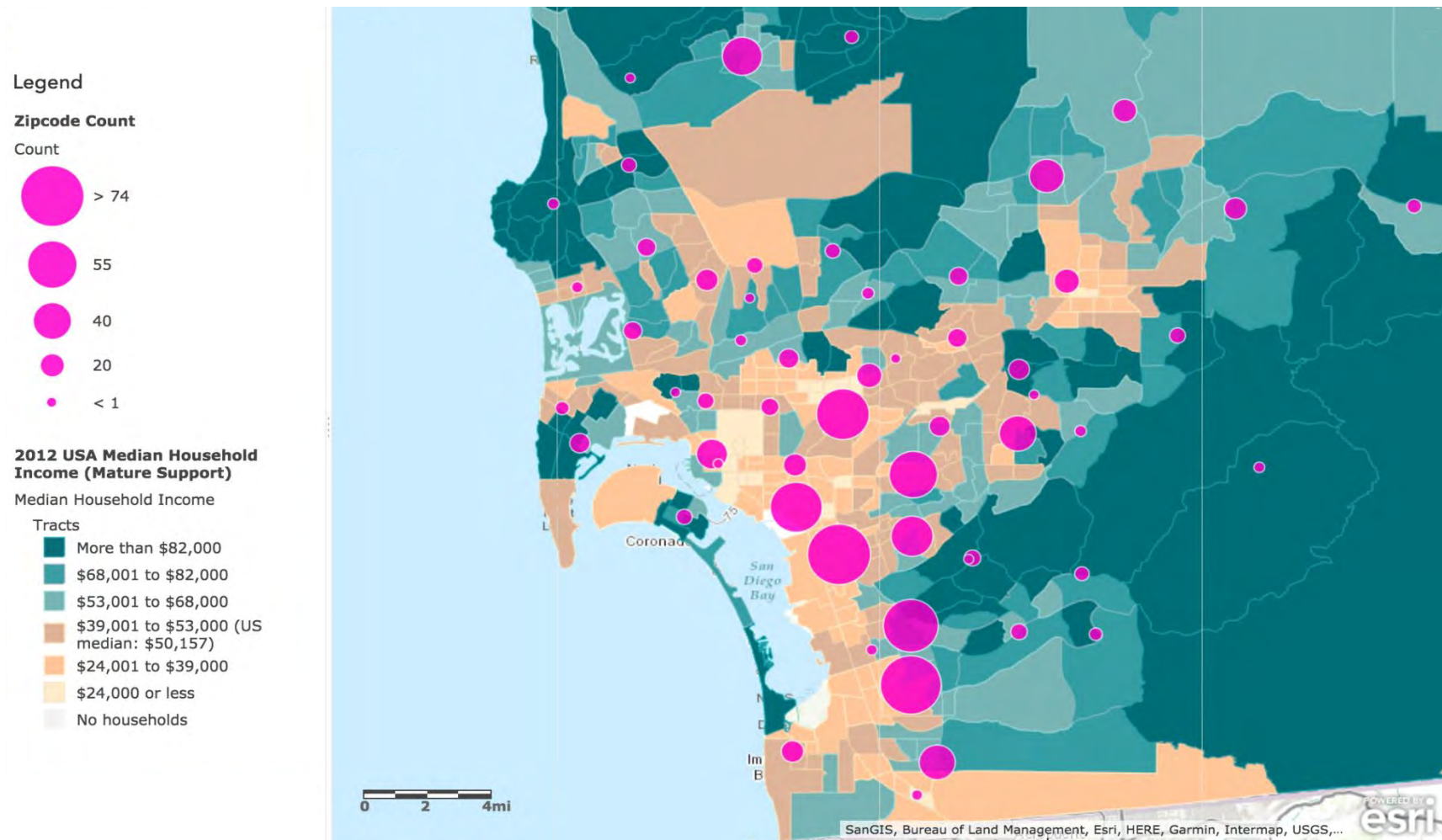
Overall, anglers ranged in age from 18 to 83 with a median of 40. This was essentially the same for those who consume fish (range: 18 to 82 with a median of 42). When placed into categories, the percent of anglers decreased as the ages increased and ranged from about 5% (<70) to almost 30% (18-30) of the anglers (Figure 16). Anglers under 40 consumed fish at a lower level than the total percent of anglers in their age class. Anglers over 40 consumed fish at a slightly higher percentage compared to the overall percent for each age category. In general, the percent of local anglers within each category eating the fish was relatively close to the relative percent in each category.



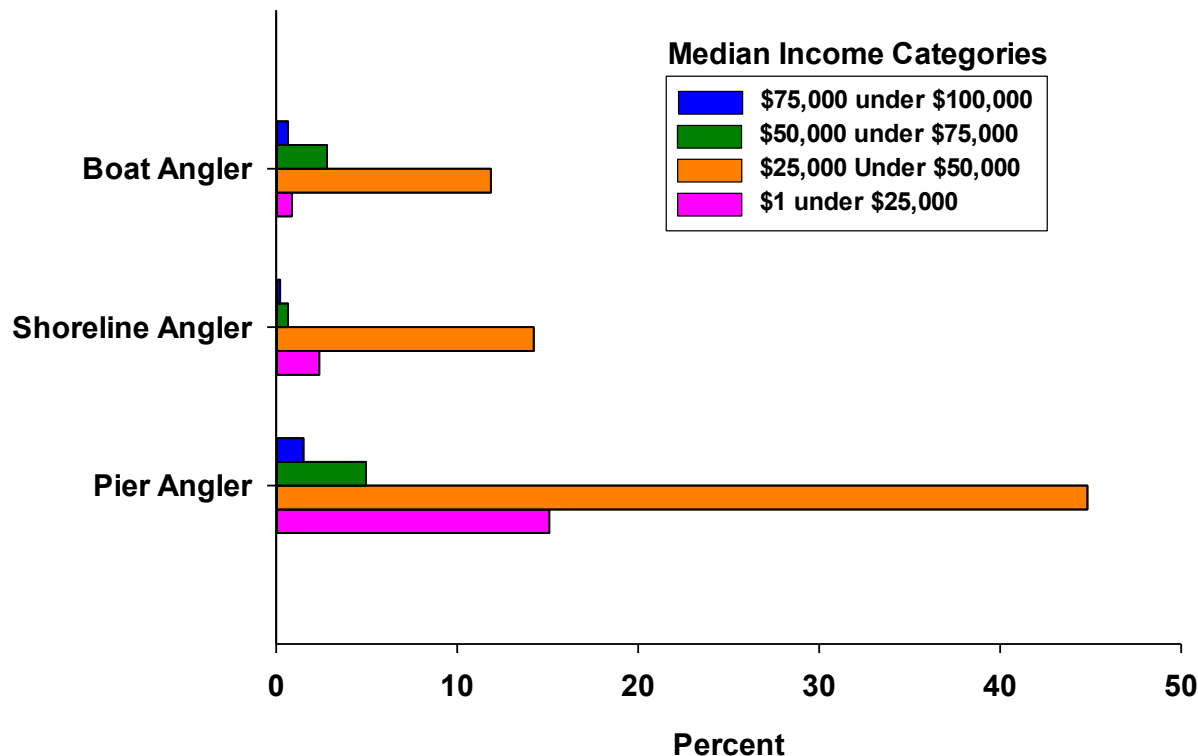
**Figure 16. Percent of anglers in different age categories by local versus all anglers.**

### Income

Anglers were placed into median household income categories based on their reported zip codes and the census information on median household incomes (US Census 2015). For 2015, the Federal poverty rate for a family of four was \$24,250. Many Federal programs determine eligibility for assistance based on multiples of the poverty rate, 200% being a more realistic number for a high-cost of living region such as San Diego. The majority of the anglers were from areas that had ZIP codes indicating a median household income between \$24,001 and \$53,000 (Figure 17). Regardless of where the angler fished from (pier, shoreline or boat), all three had the highest percentage of anglers in the \$25,000 to \$50,000 category and Pier Anglers in that category consisted of just less than 50% of the total number of anglers (Figure 18). Pier Anglers in the <\$25,000 consisted of about 15% of the anglers and comprised the second highest category overall (US Census 2015).



**Figure 17. Count of anglers by ZIP code and median household income. Note: In 2015 the U.S. Federal poverty rate for a household of four was \$24,250. A more realistic value, commonly used in higher cost locations such as San Diego is the 200% poverty rate, or \$48,500 (US Census 2015). N = 1044**



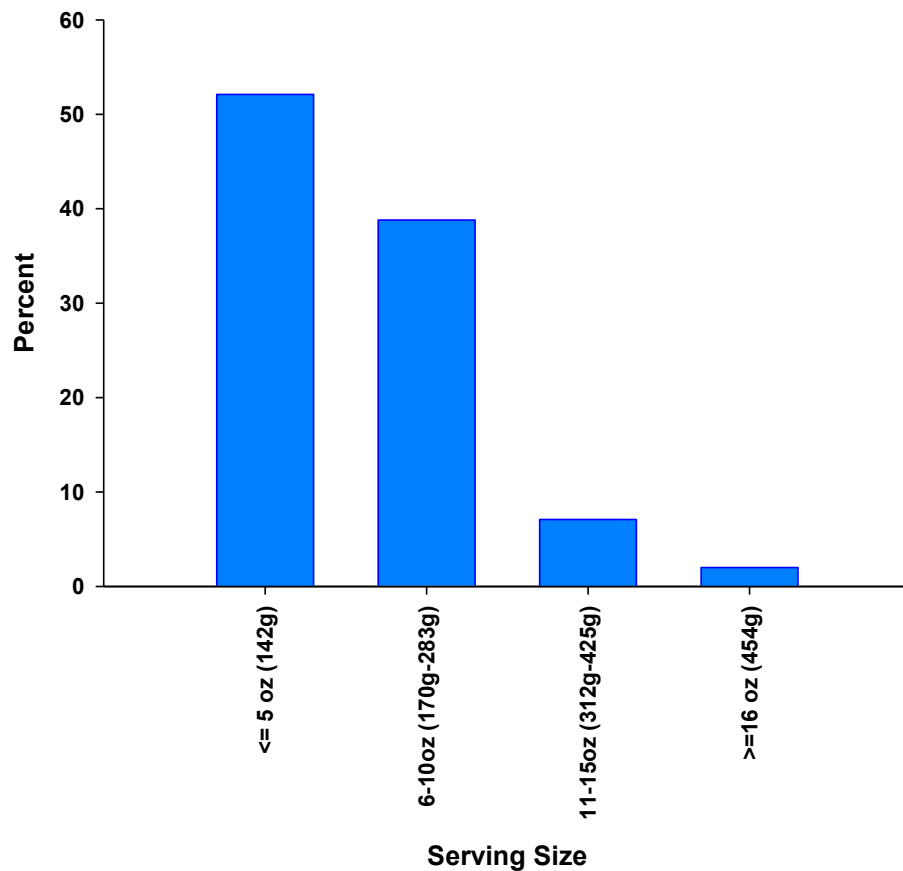
**Figure 18. Percent of anglers by angler type and median income categories as determined by home ZIP code and US Census data. Anglers indicated in pink are considered to be in poverty (family of four) based on the 2015 U.S. Federal poverty rate, and those in orange at or under the 200% poverty rate (US Census 2015). N = 464**

## Consumption Rates

Anglers typically prepared and consumed fish fillets (67%) versus preparing/consuming the whole body (33%). Reported serving sizes were in ounces with smaller serving sizes typical. Over 50% of those reporting they consumed fish ate a serving of five or fewer ounces (142 g; Figure 19) with a few people eating somewhat larger serving sizes. About 2% of the respondents claimed they consumed more than 16oz (454 g) in a meal. Overall consumption rates ranged from 0.0 to 212.6 grams per day (Table 6).

The mean consumption rate (6.3 g/day) was higher than the geometric mean consumption rate (1.5 g/day) and both were higher than the median (0.0 g/day). Higher percentiles were low compared to the maximum consumption rate, as very few values were high. Asians as an ethnicity had a mean consumption rate of 19.9 g/day, older anglers a mean consumption rate of 12.0 g/day, and children with fish caught from the bay of 8.8 g/day (because we did not collect data specifically on the age or weight of children consuming the anglers catch, the estimated

consumption rate for children was calculated using the filet size the adult angler indicated he/she typically ate). The 95<sup>th</sup> percentiles for all of these categories ranged from 28.3 g/day overall to Asians at 76.8 g/day.



**Figure 19. Percent of consuming anglers within different serving size categories. Approximately half of those who consume fish described their serving size as 5 ounces (142 g) or less. Less than 10 % of respondents considered a serving to be over 10 ounces (283 g). N = 446**

**Table 6. Descriptive statistics for Consumption Rates (grams/day).**

<b>Statistic</b>	<b>Local Anglers (San Diego Bay)</b>	<b>Asians</b>	<b>Older Than 60 years</b>	<b>Children Eat</b>
Mean (Standard Deviation)	6.3 (18.14)	19.9 (39.40)	12.0 (28.67)	8.8 (21.70)
Minimum Value	0.0	0.0	0.0	0.0
Maximum Value	212.6	212.6	212.6	212.6
Geometric Mean	1.5	5.5	3.2	2.1
Median (50th Percentile)	0.0	8.5	4.3	0.0
75th Percentile	5.7	20.6	10.6	10.6
90th Percentile	14.2	56.7	29.1	25.5
95th Percentile	28.3	76.8	42.5	35.4
99th Percentile	73.7	212.6	124.6	72.3
N*	468	67	70	146

\* Values were calculated on answers from local (San Diego region) anglers. There were 472 local anglers total; however, only 468 provided sufficient information to calculate consumption rates. N's for other categories represent a subset of this value depending on the specific question under consideration. The estimated consumption rate for children was calculated using the filet size the adult angler indicated he/she typically ate.

Consumption rates were also examined to determine if significant differences were present among socioeconomic categories. Consumption rates were significantly higher for those anglers fishing one or more times a week as compared to those fishing less than one time a week (Figure 20). Significant differences were found between anglers in the 61-70 and >70 age groups when compared to the younger age groups (Figure 21). Significant differences were found between anglers who spoke Asian and other languages versus English and Spanish (Figure 22), and differences were found between anglers of different ethnicities. In particular, median consumption rates for Asian were significantly higher than all other ethnicities (Figure 23). Consumption rates by median household income category, as determined by home ZIP code and US Census data, are approximately the same for those making less than \$50,000 a year but decrease as annual incomes exceed \$50,000 (Figure 24) (US Census 2015).



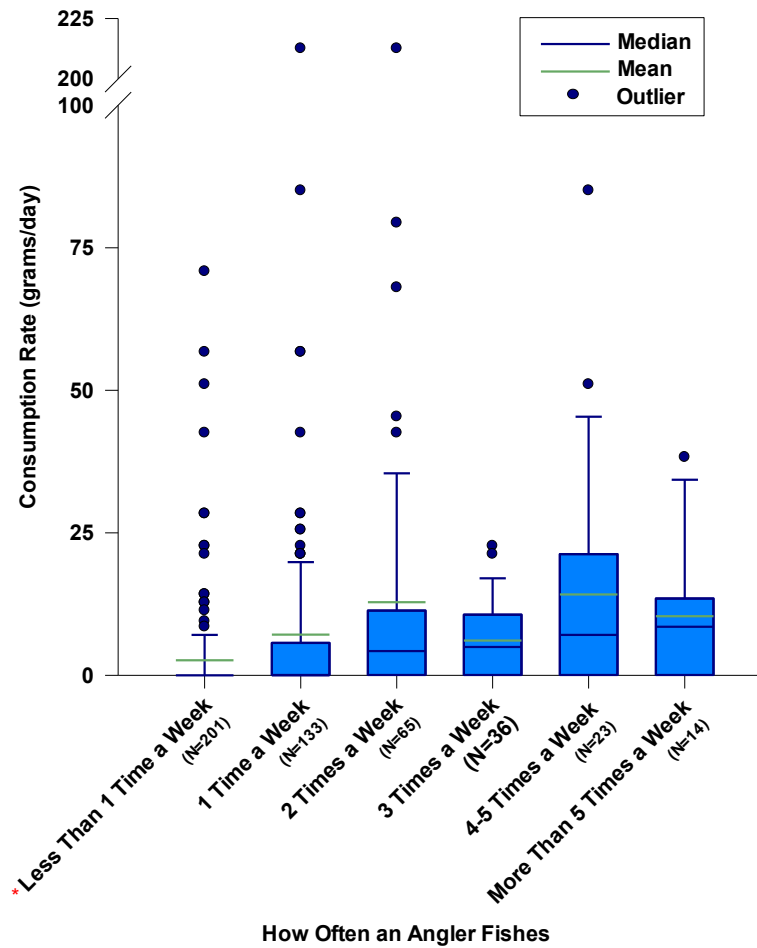


Figure 20. Consumption rate (grams/day) by how often an angler fishes per week. Less Than 1 Time a Week was significantly different ( $p \leq 0.001$ ) from the rest (red asterisk). The box boundaries indicate the 25th and 75th percentiles, the blue line within the box the median and the green line the mean. Whiskers (error bars) above and below the box indicate the 90<sup>th</sup> and 10<sup>th</sup> percentiles. N = 468

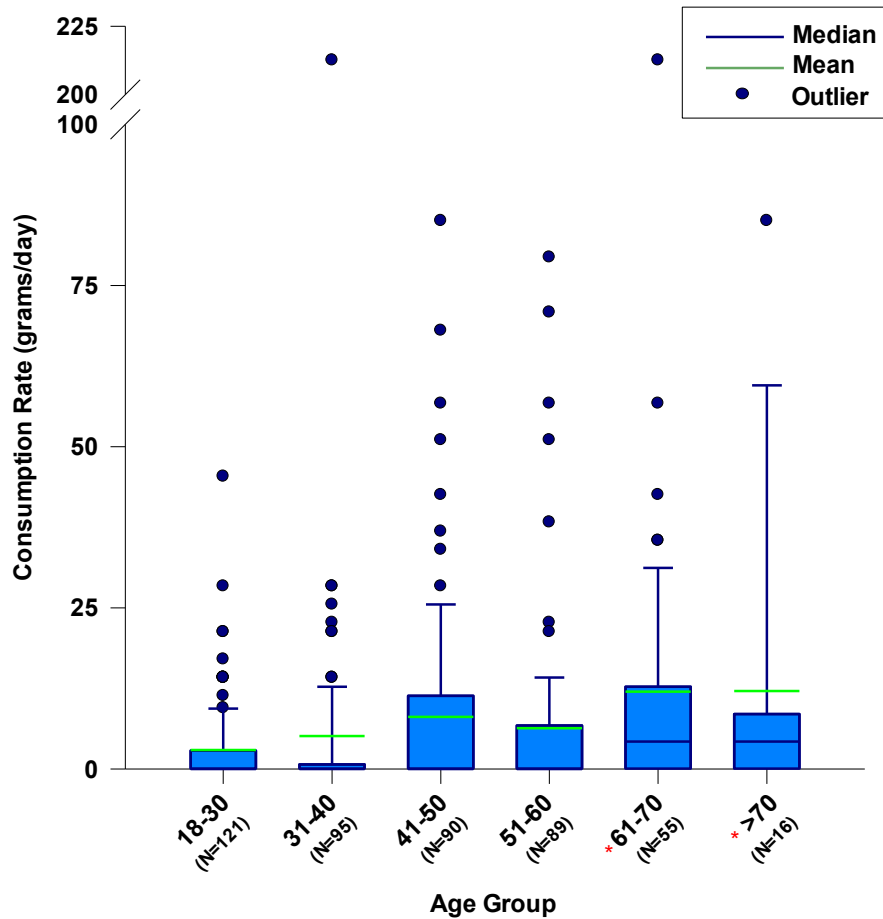


Figure 21. Differences in median and mean values for age group versus consumption rates. Age groups 61-70 and >70 were significantly different ( $p \leq 0.001$ ) from the rest (red asterisks). The box boundaries indicate the 25<sup>th</sup> and 75<sup>th</sup> percentiles, the blue line within the box the median and the green line the mean. Whiskers (error bars) above and below the box indicate the 90<sup>th</sup> and 10<sup>th</sup> percentiles. N = 462

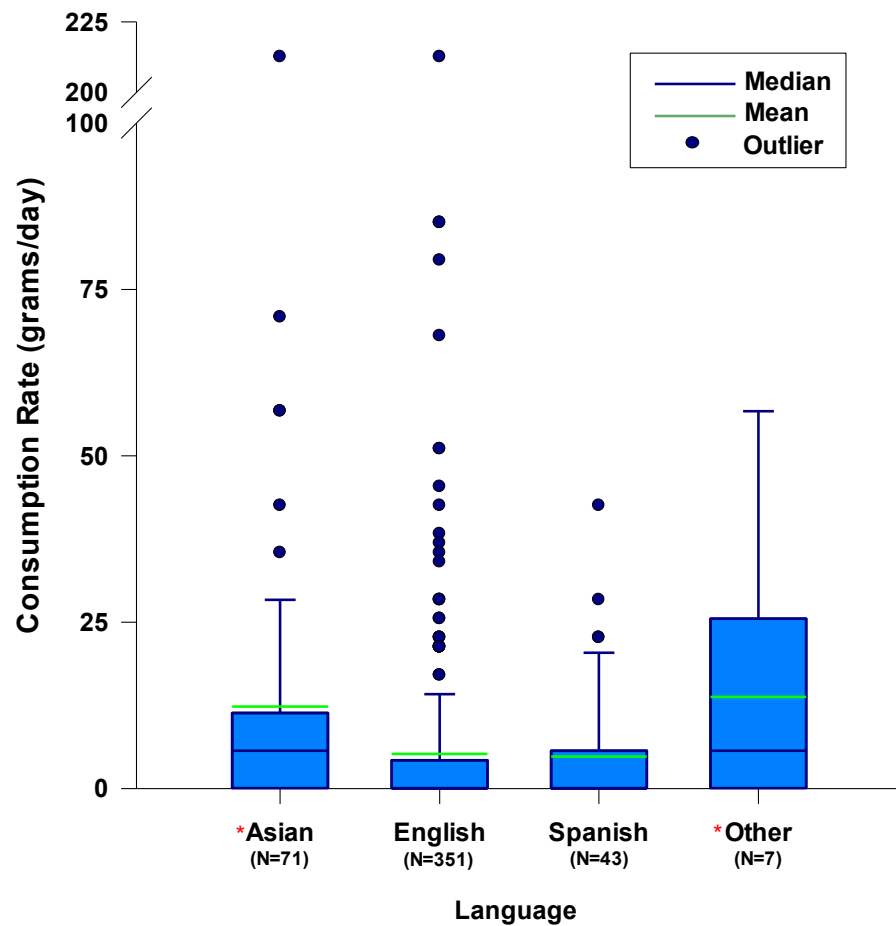


Figure 22. Differences in median and mean values for language versus consumption rates. Language groups of Asian and Other were significantly different ( $p \leq 0.001$ ) from the rest (red asterisks). The box boundaries indicate the 25th and 75th percentiles, the blue line within the box the median and the green line the mean. Whiskers (error bars) above and below the box indicate the 90<sup>th</sup> and 10<sup>th</sup> percentiles. N = 468

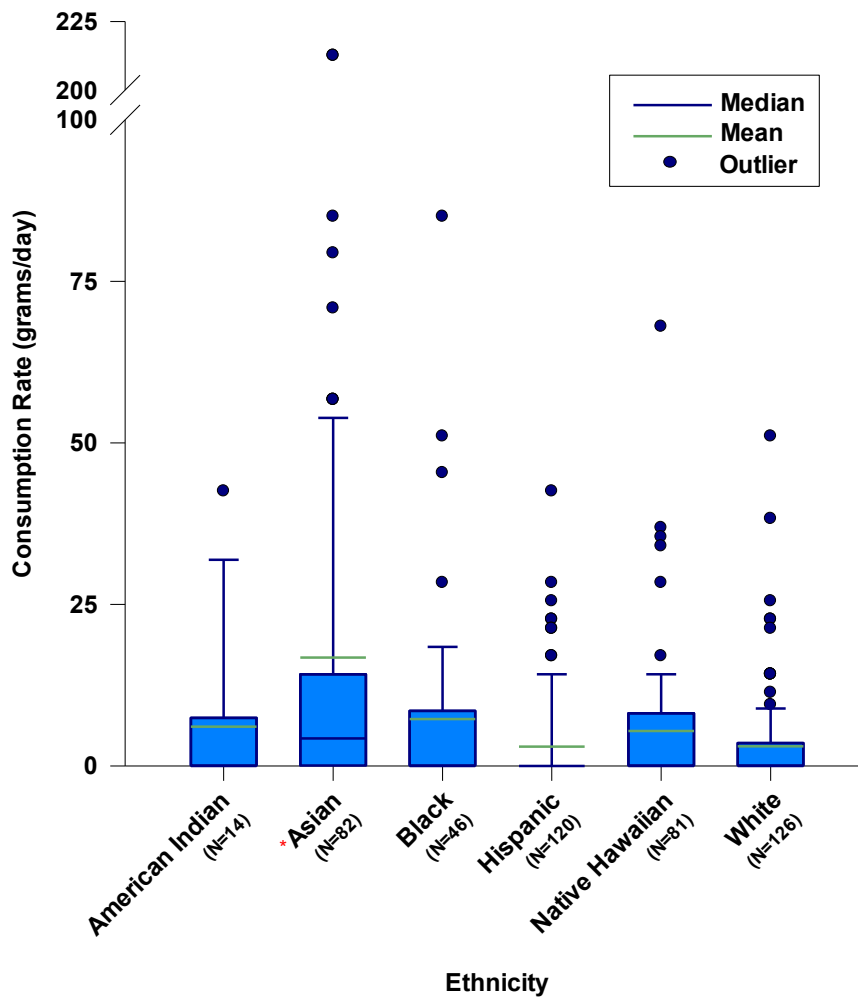
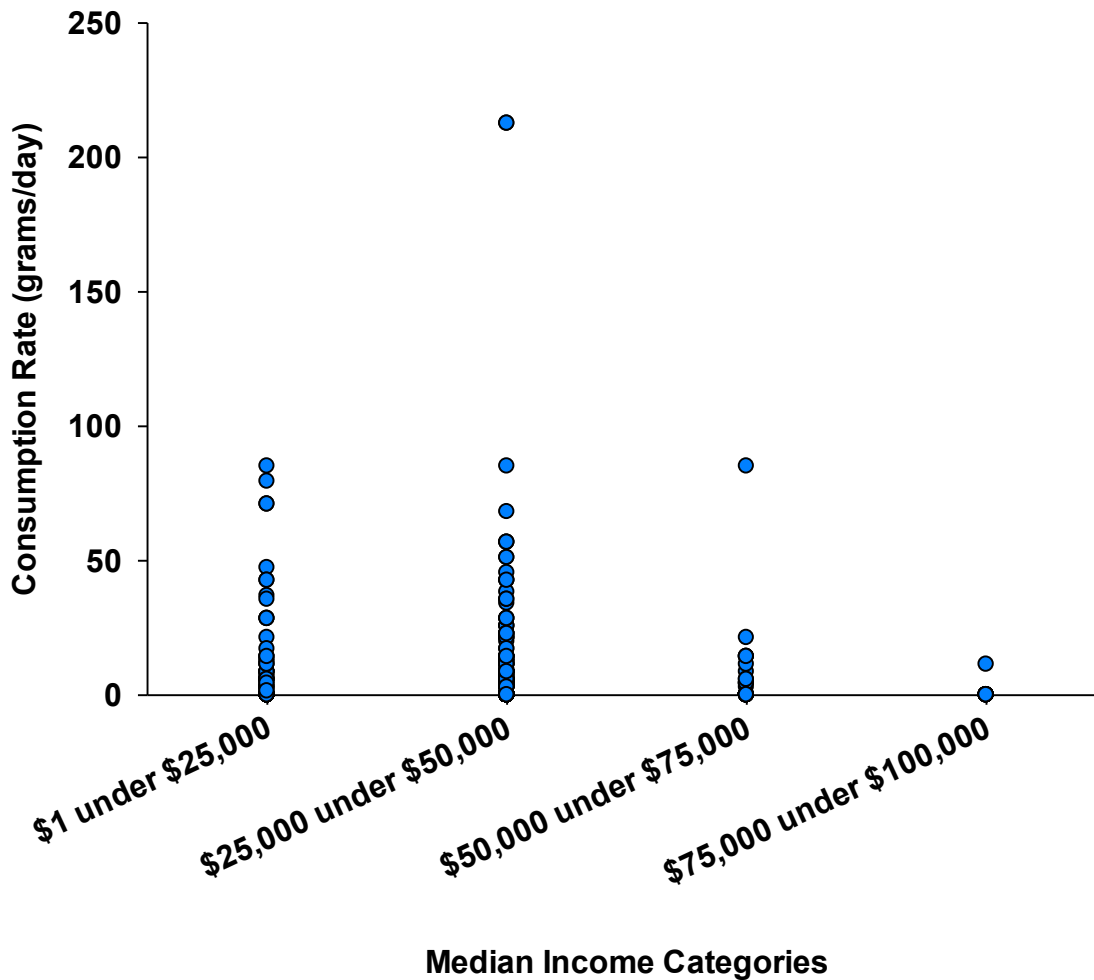


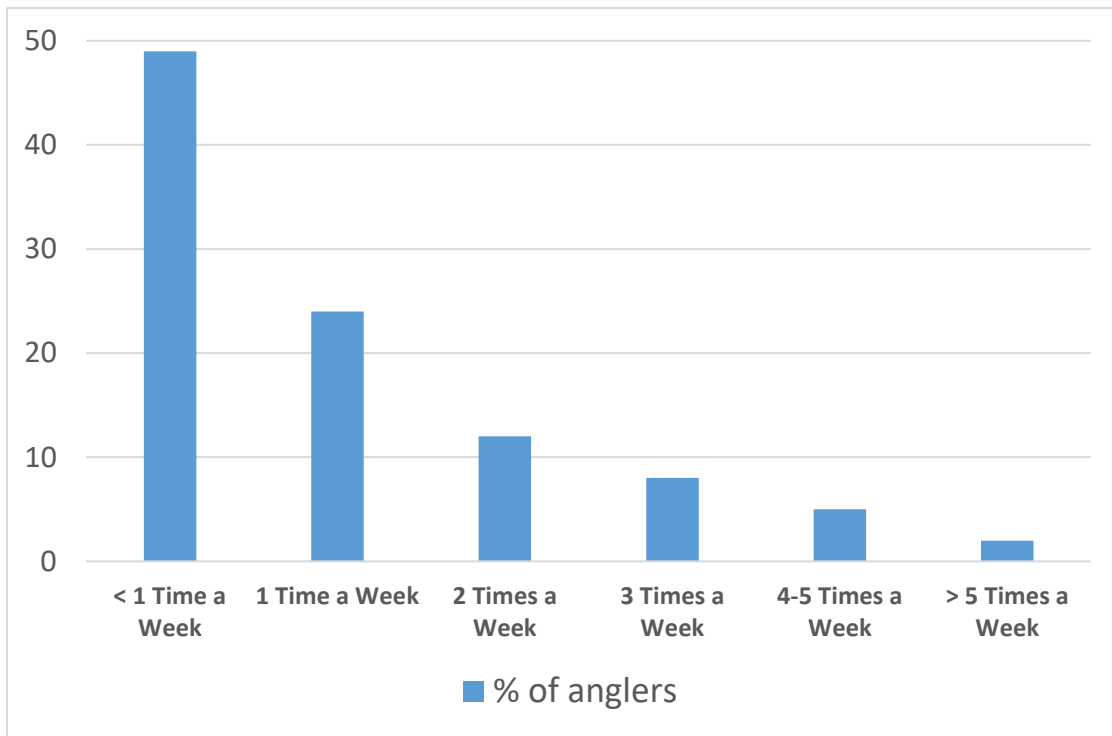
Figure 23. Differences in median and mean consumptions rates by ethnicity. The Asian ethnicity group was significantly different ( $p \leq 0.001$ ) from the rest (red asterisk). The box boundaries indicate the 25<sup>th</sup> and 75<sup>th</sup> percentiles, the blue line within the box the median and the green line the mean. Whiskers (error bars) above and below the box indicate the 90<sup>th</sup> and 10<sup>th</sup> percentiles. N = 465



**Figure 24. Consumption rate of individual respondents (blue dots) in grams/day categorized by median income. N = 461**

#### Other Angler Characteristics and Behaviors

The percentage of anglers decreased as fishing frequency increased, with 49% of the anglers fishing less than one time a week (Figure 25). About three quarters of the anglers (73%) fished one or less times a week. Only 2% of the anglers fished more than five times a week. The majority (94.5%) of anglers drove themselves to fishing locations. Human powered modes of transportation and public transportation made up the remainder nearly evenly (Table 7). Most anglers who consumed fish prepared their fish by frying it (61%; Figure 26) followed by grilling (21%) and baking it (9%). Other modes of preparation were all low (<5%).

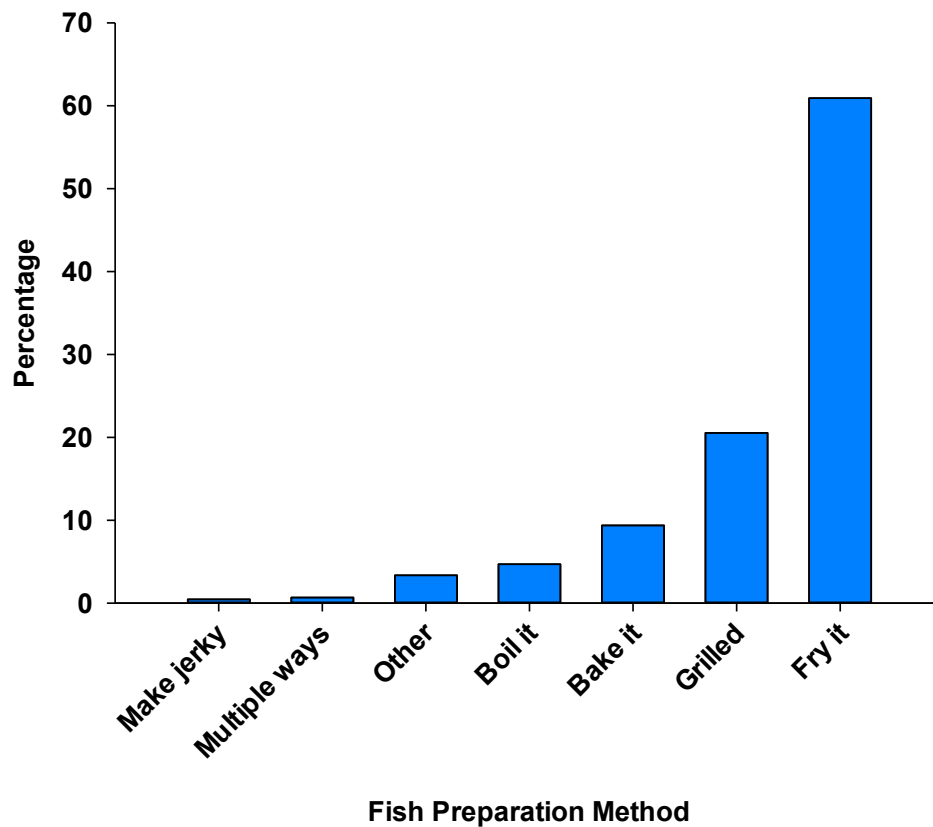


**Figure 25. Percent of anglers by how often they fish. N = 468**



**Table 7. Mode of transportation used to get to the location where fishing occurred. The majority (94.5%) used a car, while others arrived at their fishing location via some other means of public or human powered transportation. N = 472**

Mode of Transportation	Count	Percent
Own Vehicle	446	94.5
Human Powered (Bike/Walk/Got a Ride)	15	3.2
Public Transportation (Train/Bus)	11	2.3
Total	472	100.0



**Figure 26. Percentage of anglers who eat fish by how they prepare the fish for consumption. N = 448**

### What type of fish did anglers catch?

Anglers identified all species of fish they had caught in the bay and of those, which species they kept for consumption during the week prior to the interview. While many anglers (1,111) reported catching one or more fish, few (134 anglers) reported fish they had caught and kept within the week prior to the interview. The most common fish caught by anglers was the spotted sand bass (80%; Figure 27) and the Pacific chub mackerel (79%). The round stingray and California Halibut were caught about 50% of the time and smelt and bat rays about a third of the time. The rainbow surfperch and spotted turbot were both only caught about 2% of the time.

Anglers identified which species of fish they caught and kept for consumption during the week prior to being interviewed. The most common fish kept and consumed in the week prior to the interview by anglers was the Pacific Chub Mackerel which was caught for consumption within the week slightly less than half of the time (48%; Figure 28). The California Halibut and spotted sand bass was caught and consumed a less than one fifth of the time (18% and 16%, respectively), the Bonito and shortfin corvina at slightly less (12% and 7%, respectively). Other fish species consumed, included several found on the advisory list, such as: round stingray; barred sand bass; gray smoothhound shark; yellowfin croaker; shovelnose guitarfish; leopard shark; and California lizardfish were caught between 3% and 6% of the time.

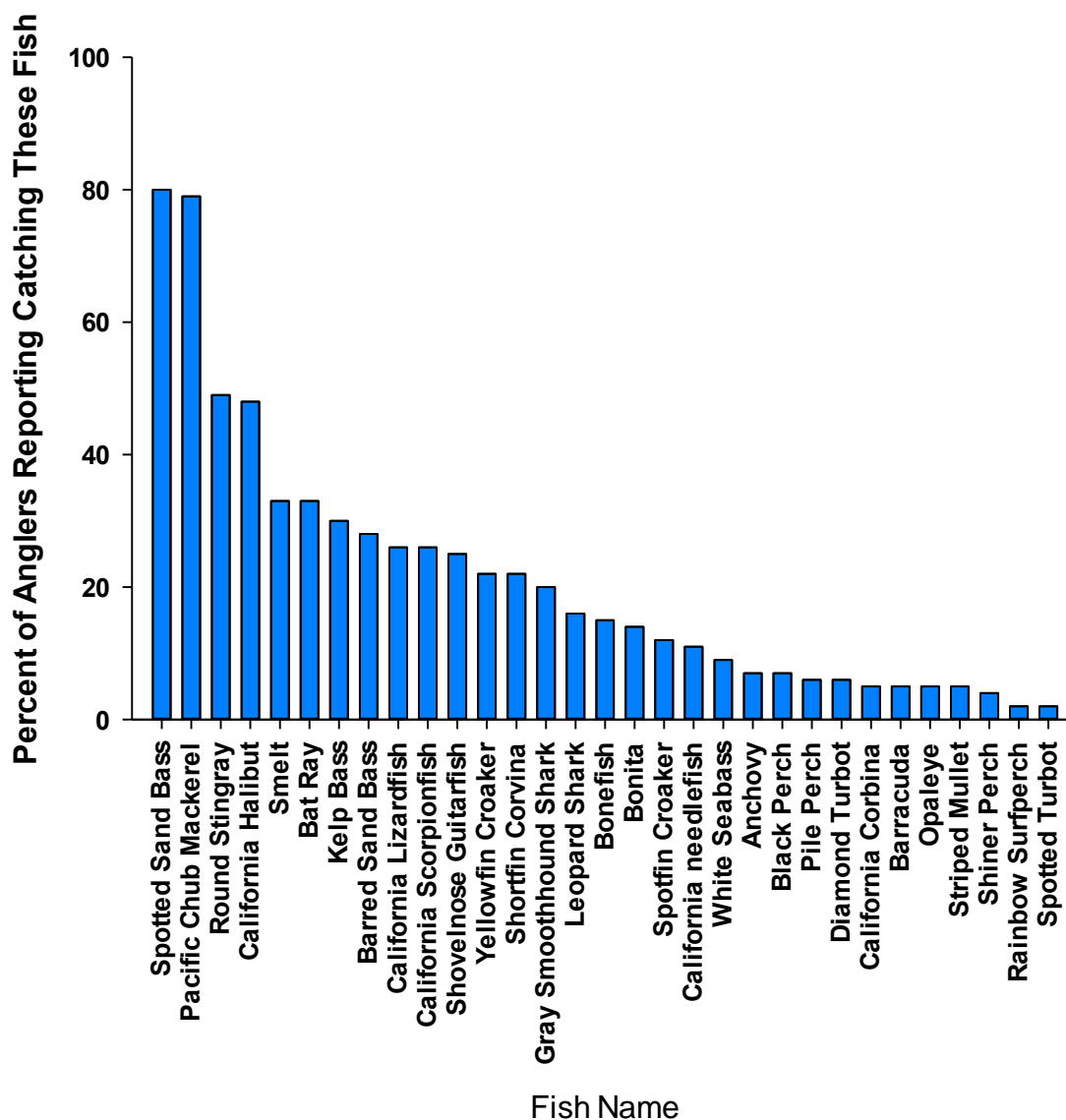
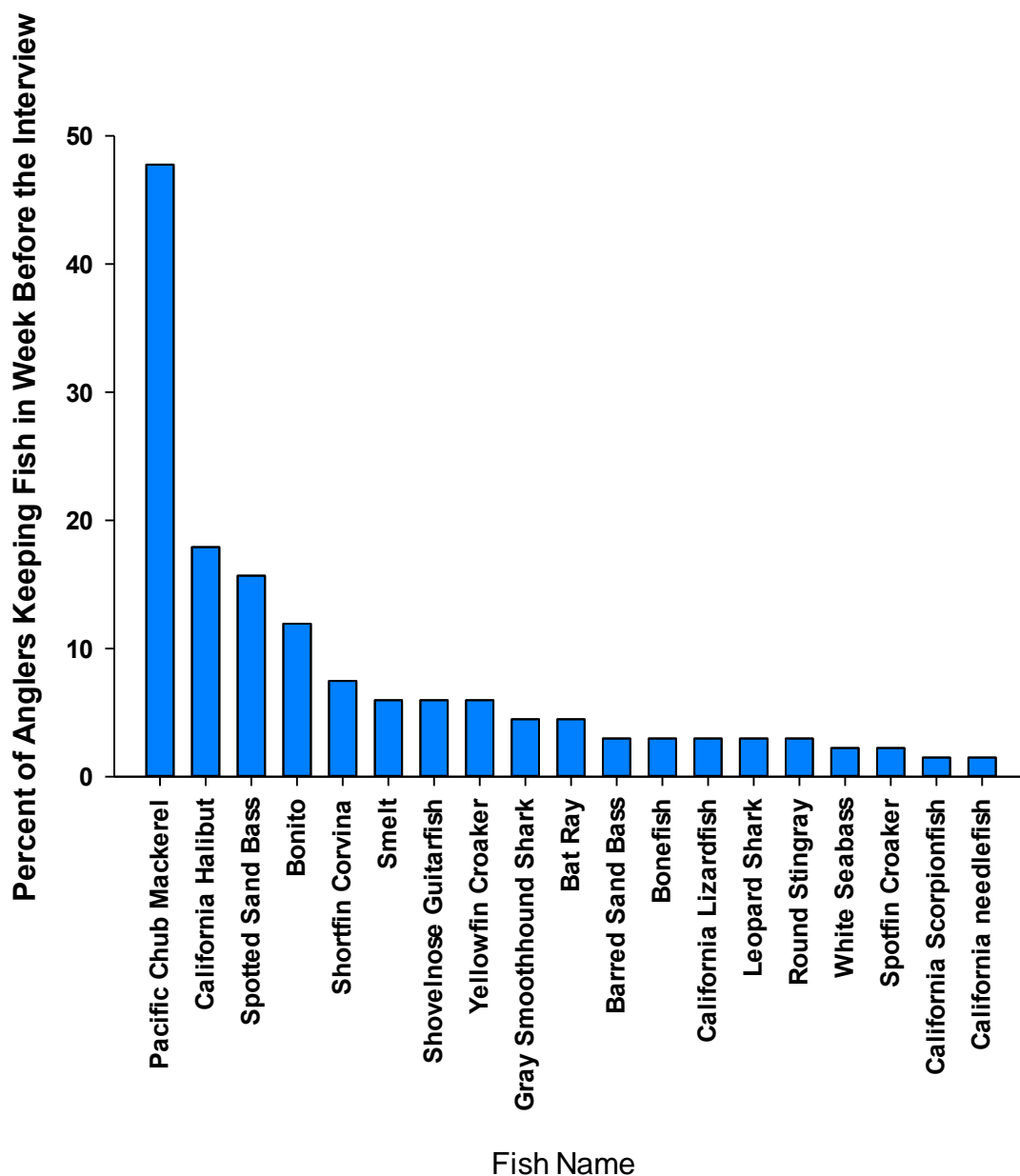


Figure 27. Percent of anglers reporting catching a given species of fish in San Diego Bay. Fish caught 1% or less of the time are not listed. N = 1111; N represents the number of anglers that responded to the question: “What types of fish do you catch when you are fishing in San Diego Bay?”

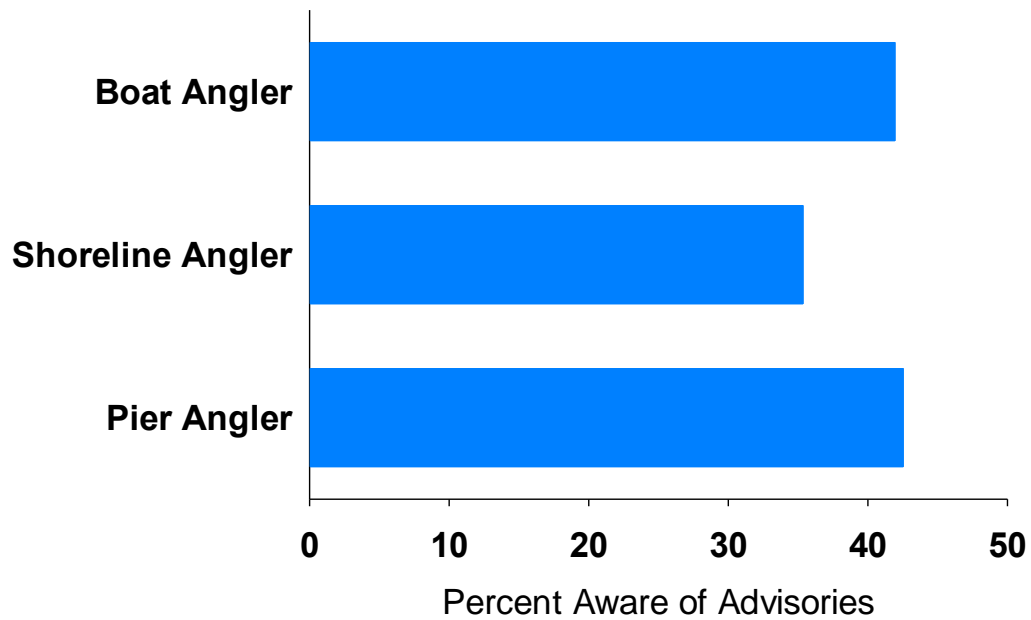


**Figure 28. Percent of anglers who caught and kept fish species for consumption within the week they were surveyed. Fish caught 1% or less of the time are not listed. N = 134; N represents the number of local people (San Diego County only) who responded to the question: “What types of fish have you caught and kept for yourself, or someone else, to eat this week in San Diego Bay?”**

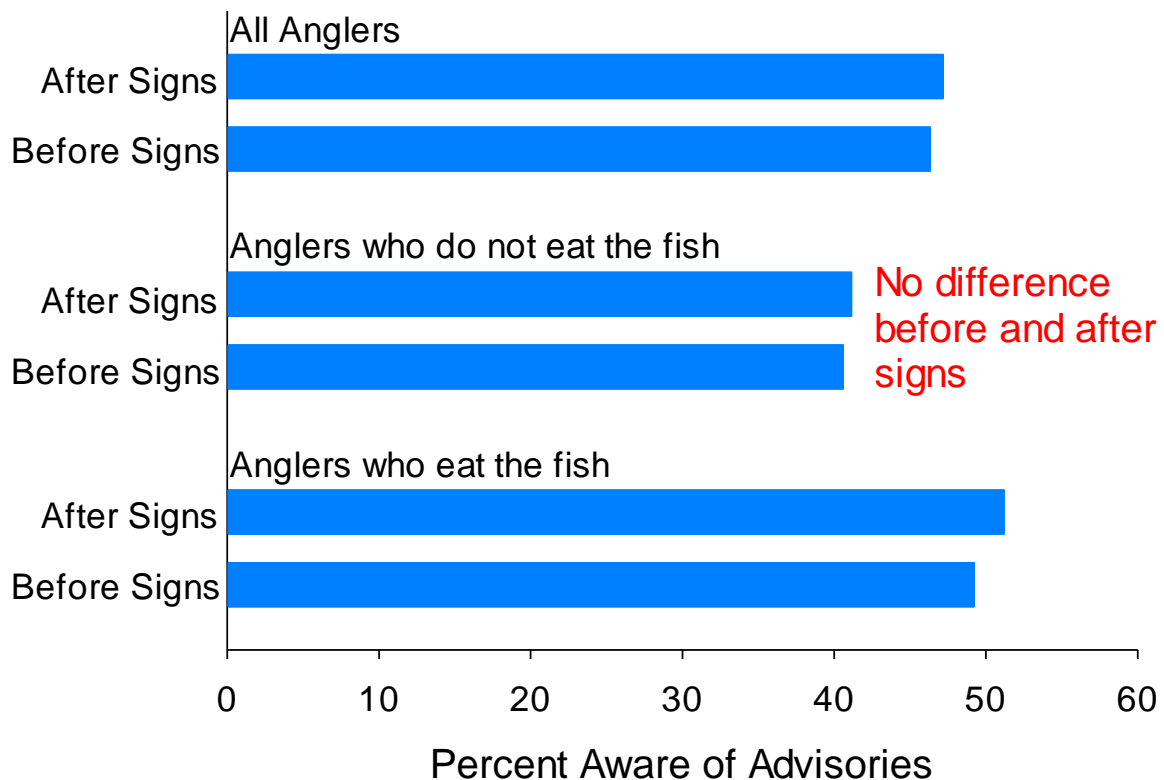
Are anglers aware of the advisories?

Less than 50% of all anglers were aware of the consumption advisories (Figure 29 and Figure 30). The percentage of Boat Anglers and Pier Anglers aware of advisories were about the same at just over 40%. Shoreline Anglers were the least aware at about 35%. Anglers who eat the fish had a slightly higher percentage of awareness of the advisories versus those that do not. No

differences were found between angler awareness before and after the new signs were put into place.



**Figure 29. Percent of all anglers by fishing type who were aware of fish advisories. Just over 40% of those fishing from boats and piers were aware compared to about 35% of Shoreline Anglers. N = 1086**



**Figure 30. Percent of anglers aware of advisories after new signs were in place. New signs were installed June 1, 2015. There was no significant difference after installation of the new signs. ( $p=0.787$ ;  $N = 1086$ )**

#### Who eats the fish the Anglers catch?

Approximately half of the anglers who consume fish they catch eat it themselves, while one-third share their catch with their families. Approximately 15% share their catch with friends (Figure 31). Almost 70% of the anglers who consume the fish they catch do not share it with children (Figure 32). The remainder feed their fish to children with approximately 25% of those feeding between one and three children. Anglers share their fish with 4 or 5 children about 6% of the time. Of the anglers who share fish with their children (and indicated the portion of fish they ate), almost two thirds consumed fillets (Figure 33) and about a third whole bodies.



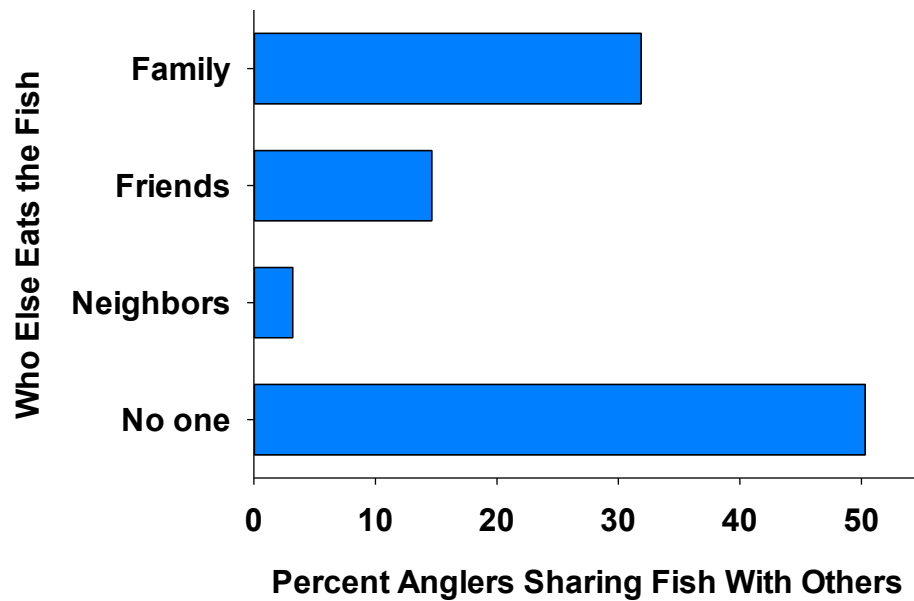


Figure 31. Percentage of anglers who share their fish with no one or others. N = 468

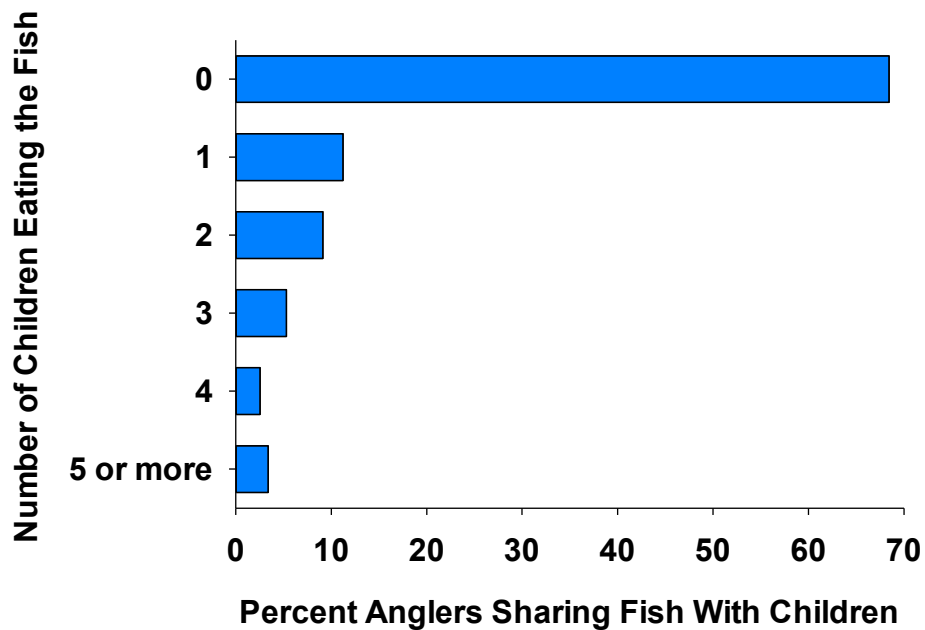
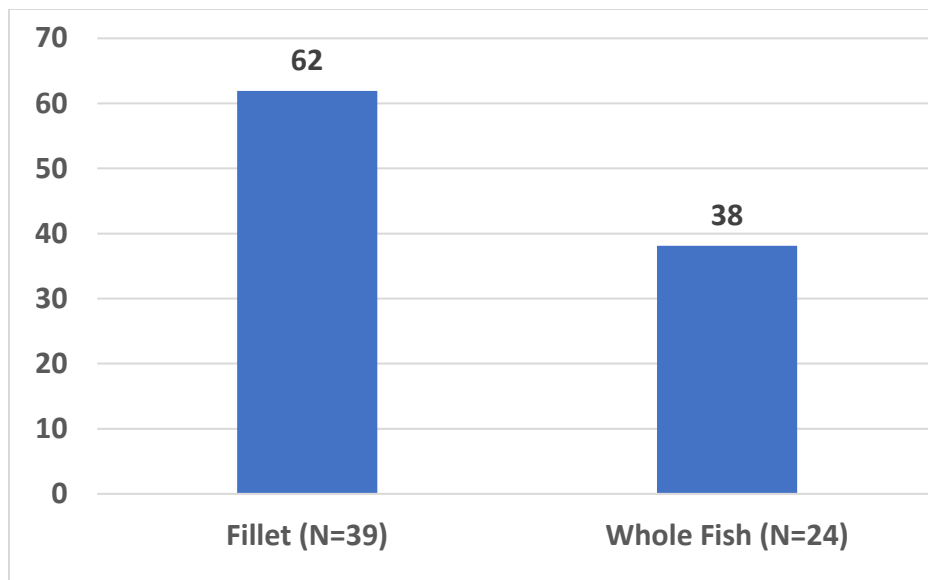


Figure 32. Percent of anglers sharing fish by number of children. N = 468



**Figure 33. Percent of anglers who shared fish with children who indicated the portion they consumed. Assumed children ate the same portion as angler.**

## **DISCUSSION**

This is the first comprehensive study of anglers in San Diego Bay. Previous studies have been limited in scope by area surveyed and time, both in the shortness of the study and the length of time since the study. Our goal was specifically to look at consumption rates of fish in San Diego Bay and determine any socio-economic differences in anglers and if the consumption rates varied in space and time within the bay.

### **Who is the Typical Angler in San Diego Bay?**

The largest angler demographic encountered during the study were middle aged, white males, however, these individuals do not tend to keep and consume their catch. Members of multiple socioeconomic groups fish in the bay as shown in our results. One concern going into the study was the possibility we would encounter non-English speaking anglers and potentially miss important populations in our interview process. In a full year of survey activity, not a single survey had to be conducted in an alternative language and only two or three anglers approached by our field crew were unable to speak English sufficiently to respond to the survey. The interviewers did not note any instances where anglers visibly attempted to avoid being approached or interviewed due to language or ethnicity. Over 70% of those interviewed indicated that English is the primary language spoken at home.

The overall ethnicity of anglers was fairly consistent with the demographics of San Diego County. Overall, the fishing population looks ethnically similar to the regional population with the fraction of Caucasians fishing was slightly less than their demographic fraction, while the number of Pacific Islanders fishing exceeded their demographic fraction. Economic status was also fairly similar to that of the general populace, though those with lower incomes did tend to consume their catch at slightly higher rates than more affluent respondents.

### **Who Eats the Fish?**

Overall, consumption rates for angler's catching fish from San Diego Bay is fairly low, and for the majority of anglers, nowhere near the levels indicated by current consumption guidelines. Anglers consuming at rates in excess of guidance are typically middle-aged or older Asian men from socioeconomically disadvantaged communities. This is the single socioeconomic group which appears to indicate a pattern consumption which exceeds the current consumption guidelines. While the signs indicating consumption guidance are posted at locations frequented by these individuals (and others in the high consumption groups), awareness of either the old or new signage did not appear to have a significant impact on behavior.

Others who consume fish from the bay are less consistent making the identification of particular social or ethnic groups at risk more difficult. However, with the exception of a very small number of high consumers, few if any individuals are consuming fish at rates in excess of the recommended guidelines or sharing these fish in large quantities with family or friends. In short, subsistence fishing in the bay appears to occur at a very low level.

Because signage regarding consumption appears to have reached a saturation point, meaning there is not a significant level of additional behavior change due to the presence of the signs, old or new, if there is an effort to educate at-risk populations about the over-consumption of fish

from the bay, there are two approaches which may help to limit risk to anglers consuming fish from the bay: 1) take action to reduce the contamination levels in the fish by through clean-up of contamination sources; or 2) use targeted education programs directed to the most at-risk anglers, primarily in the Asian community, through direct interaction at the community level to ensure they are aware of the risk and can make informed decisions about their consumption. Visits to community groups and gatherings may prove more effective than additional signs or information posted online.

### **What are the Consumption Rates for Anglers in San Diego Bay?**

Of those anglers that indicated they consume their catch, for the most part, consumption rates are low. The arithmetic mean consumption rate of 6.3 grams/day and median of 0.0 grams/day is well below that found in other studies (Shilling et al. 2010; Shilling et al. 2014, SFEI 2000, Allen et al. 1996) This studies mean is lower compared to other large studies done in California's Central Valley Delta (27.4 grams/day; Shilling 2010), San Francisco Bay (23.0 grams/day; SFEI 2000) and Santa Monica Bay (50 grams/day). Overall, consumption rates were higher for those anglers that fished one or more times a week. The most identifiable group who appears to be at risk of overconsumption were of the Asian ethnicity. Anglers who spoke an Asian language and those over 60 years of age also had higher consumption rates. However, the mean consumption rates even for these groups, were still lower than for the other studies.

Percentile rates have been used to set consumption rates, for example the USEPA recommends using a 90th percentile rate of consumption to protect the general population, and a 99th percentile rate to protect anglers who consume their catch (USEPA 2000). In California, the 95<sup>th</sup> percentile rate of consumption from regional studies have been used by both the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB 2006) and the Central Valley Water Quality Control Board (CVRWQCB 2010) to protect fish consumers. The USEPA rates of consumption and the consumption rate calculated for San Francisco Bay anglers (95th percentile rate=32 g/day), have been used by Central Valley Regional Water Quality Control Board (CVRWQCB 2008) to set target fish tissue concentrations for the Delta through the TMDL process and the 95<sup>th</sup> percentile for this study of 28.3 grams/day is relatively close to that value.

### **How do Consumption Rates Vary by time of Year?**

One reason to conduct a full calendar year of field sampling was to explore if there were any seasonal variations either due to anglers fishing for food around particular holidays and cultural events or due to particular species being more available at particular times of year. Overall, we did not identify any significant differences in consumption rates based on the time of year ( $p=0.143$ ). While some additional activity from non-local anglers occurred during common vacation times, these individuals were almost always fishing for recreational purposes and not consuming their catch. Additionally, because non-local anglers do not fish in the bay on a year-round basis, any consumption is limited to the duration of a short visit to the area and does not present any significant risk of over-consumption.

## **How Often And Where Do Consuming Anglers Fish In San Diego Bay?**

Most of the fishing activity captured through this study occurs from the public piers located around the bay. This may be, in part due to the easy access and no requirement for a fishing license when fishing from the piers. This is supported in part by the fact that most of those who are fishing reside in census tracts that are below the 200%, and in many cases 100% poverty level for a family of four (US Census 2015). Fishing from the pier does not require a fishing license, thereby allowing anglers to avoid the added cost to obtain a license or the risk of being cited for fishing without one. By contrast, those fishing from the shoreline or a boat are required to possess a valid license. Of course, Boat Anglers must either own a boat, and a means to transport it to the ramp, or rent a boat from one of the local rental facilities to gain access the bay. These additional costs may serve to further limit the type of individuals who choose to fish via those modes. As noted previously, boat fishing may also be under-represented due to the limited opportunities to contact those anglers only when entering or exiting the water.

Approximately 70% of those fishing do so one time per week or less. This supports our observation that consumption rates are not particularly high for most anglers. For the 30% of anglers who do fish more than once a week, many do so purely for recreation and did not keep or consume their catch. Regionally, consumption rates were not different for anglers. More specifically, those that fished in the North, Middle and South Bay areas did not differ.

## **What Fish are Typically Caught and Consumed?**

While many species were reported in our interviews during the course of the year, the ten most reported as commonly caught and the ten most commonly kept had seven species in common (Table 8). Of those commonly caught, six are listed on the consumption advisory guidelines for San Diego Bay, three of which were listed as “do not eat” species (spotted sand bass, barred sand bass and topsmelt) for women 18-45 and children 1-17 years. Of those reported as caught and kept within the week prior to the angler being interviewed, six were listed on the consumption advisory guidelines. Five of the six were in common with those species reported as commonly caught. The Round Stingray, Barred Sand Bass, and California lizardfish were reported as commonly caught but did not appear in the top ten for fish kept for consumption in the prior week. The same two species reported caught and on the “do not eat” list (Spotted Sand Bass and Topsmelt) were all in the top ten caught and kept list with the addition of the yellowfin croaker and gray smoothhound shark.

**Table 8. Top ten fish reported caught in general and reported as kept in the week prior to being surveyed. Blue text indicates fish in common between the two lists and an asterisk (\*) indicates inclusion on the fish consumption advisory guidelines for San Diego Bay.**

Fish Reported Caught		Fish Caught and Kept to Consume	
Fish Name	Percent	Fish Name	Percent
Spotted Sand Bass*	80	Pacific Chub Mackerel*	48
Pacific Chub Mackerel*	79	California Halibut	18
Round Stingray*	49	Spotted Sand Bass*	16
California Halibut	48	Bonito	12
Topsmelt*	33	Shortfin Corvina	8
Bat Ray	33	Topsmelt*	6
Kelp Bass	30	Shovelnose Guitarfish*	6
Barred Sand Bass*	28	Yellowfin Croaker*	6
California Lizardfish*	26	Gray Smoothhound Shark*	5
California Scorpionfish	26	Bat Ray	5

### **Are Anglers Aware of Advisories?**

There was approximately a 50-50 split in anglers who were aware of advisories and those who were not. While signs have been posted at the piers and launch ramps for a number of years, we anticipated with the posting of new, full color signs, perhaps the awareness would increase. There was no significant difference in awareness following posting of the new signs. Furthermore, awareness of advisories does not appear to have any noticeable impact on consumption behavior. This is not to imply the posting of signs and other information is not valuable, but rather, that even when anglers are aware of the potential risk, about half of them will still consume some of their catch, and for the most part do so at levels substantially below those indicated in the guidance.



## RECOMMENDATIONS FOR FUTURE STUDIES

### Interview Follow-ups

Interview based research demands a careful balance, to obtain high response rates, the survey cannot last too long or lead the respondent to give up part way through the process. While we considered a number of additional potential questions which may have provided more specific details for analysis, we opted to rely on alternative data sources such as the US Census to tie various socioeconomic details to response groups based on their hometown and home ZIP code.

An interesting follow-up study for those anglers fishing in San Diego Bay who do not consume the fish would be: *If the bay was cleaned up such that there were no consumption limitations, would you eat the fish?* It would also be interesting to explore which species they would consume and how frequently.

A valuable follow-up to this study would be to go into some of the neighborhoods where high consumption rate anglers reside and do more in-depth focus group interviews with those communities to better understand their consumption behavior and the underlying reasons for it. Such a study could also provide a basis for conducting additional outreach and education with these communities regarding ways to limit risks associated with consumption of fish from the bay, including preferred species, preparation methods, and alternatives.

### Electronic Data Collection and Submission

Use of the tablets with a mobile app help to both ensure data was recorded consistently and captured to the core database in a timely manner. This reduced the risk of data loss and transcription errors and streamlined the overall process. In some cases, particularly when non-constrained answer indicated as “other” were provided, we did experience a number of data entry inconsistencies in spelling or terminology used. However, the limited number of open ended questions made normalization of those responses much more feasible than had these been collected in handwritten form on paper data sheets.

Occasionally tablets were difficult to see without shielding them from sun glare. Field crews worked out a means to do this consistently using their clip board as a shade. We also experimented with different colors, contrast settings, and interface design used in the app to optimize viewing in bright sunlight. Field teams always carried two tablets in their car when going to the field to guard against any unforeseen hardware or battery issues. They also had paper survey sheets available as a backup, however, the Android tablets functioned well throughout the survey year and we never had a sampling days during which at least one of the tablets could not be used.

Additionally, the effectiveness of the mobile devices for field data collection was better than expected. In concert with the fish photos and model fillets, there was a high degree of data quality and completeness throughout the study. Furthermore, by receiving back data on a regular basis throughout the study period, we were able to monitor our progress, rapidly and automatically generate monthly updates and ultimately have a consistent and ready-to use data set for analysis at the conclusion of the sampling period.

## **Future Opportunities**

The approaches developed in this study to effectively sample across a multivariate series of fishing modes, locations, and times of day, week and season would be valuable to consider in any future consumption study.

We maintained consistency with prior consumption studies for many of the survey questions, to provide a basis for comparability, and this is something we would recommend for similar studies in the future. While we did not observe any significant variations by season for San Diego Bay, this may not be the case in other regions that experience more dynamic seasonal variability, such as central and northern California.

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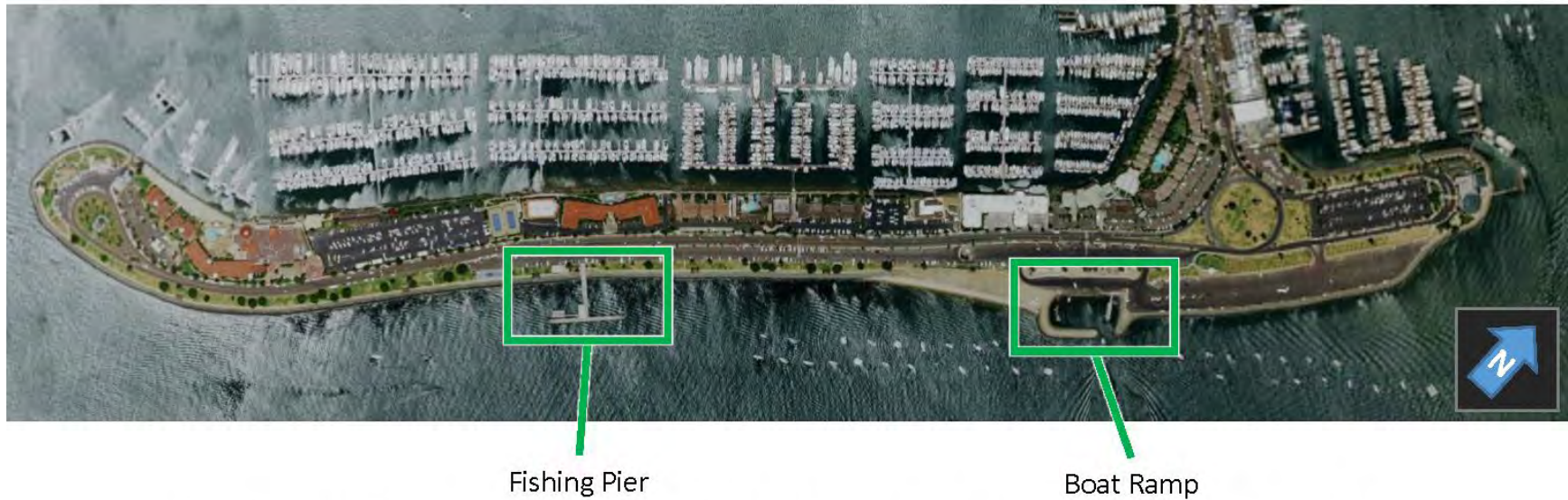
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## APPENDIX A: FIELD SITE DETAILS

### North Bay Site A (Shelter Island)



Access for fishing from pier and shoreline fishing possible along most of Shoreline Park



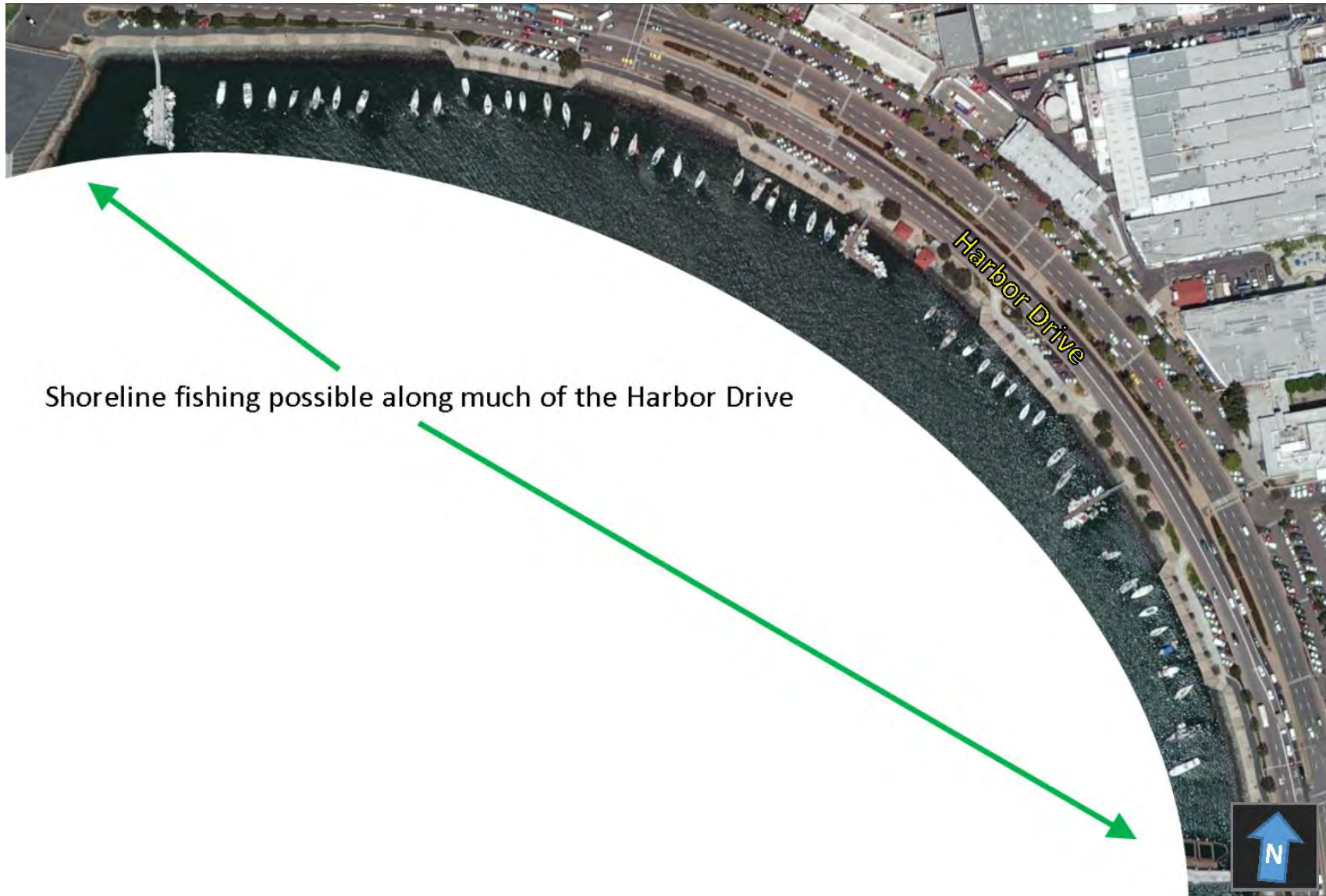
## North Bay Site B (Harbor Island and Liberty Station NTC Park)



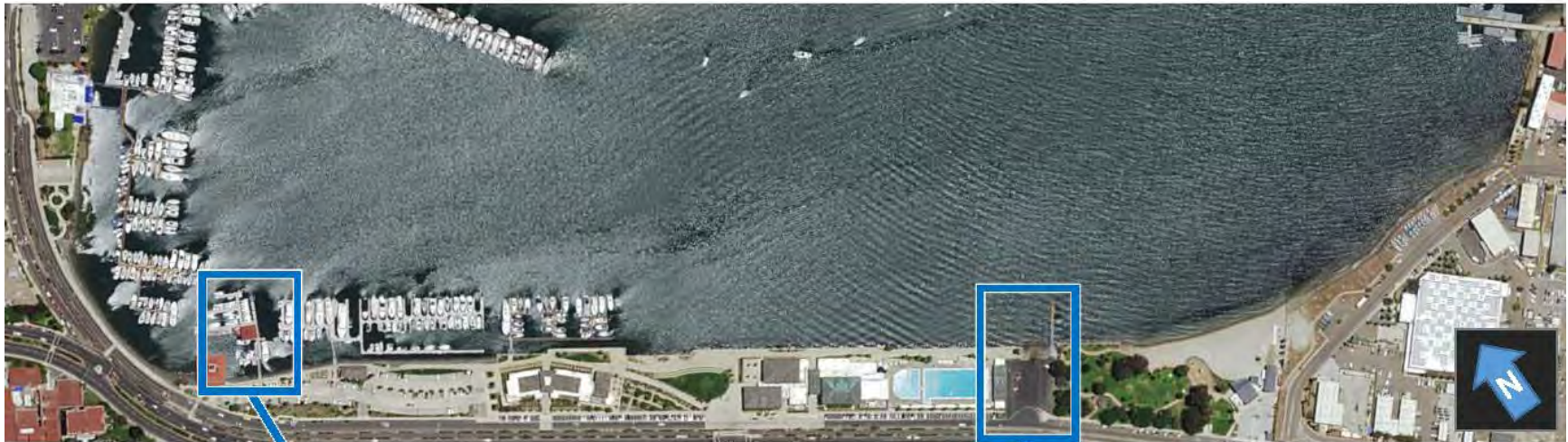
Shoreline fishing possible along much of both the Harbor Island and Liberty Station NTC Park waterfronts



## North Bay Site C (Harbor Drive, north of downtown)



## Mid Bay Site A (Glorietta Bay Park)



Rental Boats

Boat Ramp

Shoreline fishing is also possible along some areas of Glorietta Bay Park



## Mid Bay Site B (Coronado Tideland Park)



Shoreline fishing is possible along most of Coronado Tideland Park



## Mid Bay Site C (Coronado Ferry Landing)



Pier fishing at Coronado Ferry Landing and shoreline fishing is possible nearby



## Mid Bay Site D



Pier fishing at Embarcadero Marina Park South. Shoreline fishing is possible in both Embarcadero Marina Park North and South

## Mid Bay Site E (Cesar Chavez Park)



Shoreline fishing along Cesar Chavez Park is available (no public pier)



## South Bay Site A (Pepper Park)



Fishing from public pier and bridge near park (accessible by foot) and shoreline fishing also possible. Also offers a boat ramp.

## South Bay Site B (Bayside Park/Chula Vista Bayfront Park)



No public pier, shoreline fishing is possible. Also offers a boat ramp.



## APPENDIX B: FISH PHOTOGRAPHS





17) Bat Ray



18) Gray Smoothhound Shark



19) Leopard Shark



20) Round Stingray



21) Shovelnose Guitarfish



22) Bonefish



23) Pacific Chub Mackerel



24) California Lizardfish



25) Striped Mullet



26) Pacific Mackerel



27) California Scorpionfish



28) Smelt



29) California needlefish



30) Anchovy



## APPENDIX C: SURVEY SCHEDULE

Fish Consumption Study Master Field Schedule - Pre Signs																
Season	SPRING 2015															
Sequence	Pier --> Ramp --> Shore				Ramp --> Shore --> Pier				Shore --> Pier --> Ramp				Pier --> Shore --> Ramp			
Field Day	Mon	Tue	Sat	Sun	Wed	Fri	Sat	Sun	Wed	Thu	Sat	Sun	Mon	Fri	Sat	Sun
Date	4-May	5-May	9-May	10-May	13-May	15-May	16-May	17-May	20-May	21-May	23-May	24-May	25-May	29-May	30-May	31-May
North	A		B	C		C	B	A	B		A	B	C		A	
Middle		C	A		C				A	B	C		A	B	C	B
South	B	A		A	A	B	A	B		C		C		C		C
Fish Consumption Study Master Field Schedule - Post Signs																
Season	SUMMER 2015												FALL 2015			
Sequence	Ramp --> Shore --> Pier				Shore --> Pier --> Ramp				Pier --> Ramp --> Shore				Ramp --> Shore --> Pier			
Field Day	Wed	Sat	Thu	Sun	Fri	Sat	Mon	Sun	Mon	Sat	Tue	Sun	Wed	Sat	Thu	Sun
Date	3-Jun	13-Jun	18-Jun	21-Jun	3-Jul	11-Jul	13-Jul	19-Jul	27-Jul	8-Aug	10-Aug	16-Aug	26-Aug	5-Sep	10-Sep	13-Sep
North	C	A			B	C			C	A			B	C		
Middle		C	A			B	C			C	A			B	C	
South			C	A			B	C			C	A			B	C
Season	FALL 2015								WINTER 2015 - 2016							
Sequence	Shore --> Pier --> Ramp				Pier --> Ramp --> Shore				Ramp --> Shore --> Pier				Shore --> Pier --> Ramp			
Field Day	Fri	Sat	Mon	Sun	Tue	Sat	Wed	Sun	Thu	Sat	Fri	Sun	Mon	Sat	Tue	Sun
Date	25-Sep	3-Oct	5-Oct	11-Oct	20-Oct	31-Oct	5-Nov	8-Nov	19-Nov	28-Nov	4-Dec	6-Dec	14-Dec	26-Dec	29-Dec	3-Jan
North	A	B			B	C			A	B			C	A		
Middle		A	B			B	C			A	B			C	A	
South			A	B			B	C			A	B			C	C
Season	WINTER 2015 - 2016												SPRING 2016			
Sequence	Pier --> Ramp --> Shore						Ramp --> Shore --> Pier						Shore --> Pier --> Ramp			
Field Day	Wed	Sat	Thu	Sat	Fri	Sat	Mon	Sat	Tue	Wed	Sun	Sun	Thu	Sat	Sun	Fri
Date	6-Jan	9-Jan	14-Jan	16-Jan	22-Jan	23-Jan	1-Feb	6-Feb	9-Feb	17-Feb	21-Feb	28-Feb	3-Mar	5-Mar	13-Mar	18-Mar
North	A	B				Fishing Derby Shelter	C	A					B		A	
Middle			A	B					C	A				C		B
South					A						C	A				
Season	SPRING 2016															
Sequence	Shore --> Pier --> Ramp		Pier --> Ramp --> Shore								Start		End		Spring: March - May	
Field Day	Mon	Sat	Tue	Sat	Sun	Wed	Sun	Thu	Timeslots		A		5:00 AM		11:00 AM	
Date	21-Mar	26-Mar	5-Apr	9-Apr	17-Apr	20-Apr	24-Apr	28-Apr			B		10:00 AM		4:00 PM	
North			C	B							C		3:00 PM		9:00 PM	
Middle					C	A							Weekday		Weekend	
South	B	B					C	A								
Summer: June - August																
Fall: September - November																
Winter: December - February																

## APPENDIX D: SURVEY QUESTIONS

### Pre-survey Questions:

- 1) Initiate Survey Choose type of Angler (Pier, Shoreline or Boat) – this also captures the date, time, and GPS location of the survey.
- 2) Have you ever been surveyed before for our San Diego Bay fish consumption study?  
Yes                      No

IF YES: How long ago did you do the survey?

- A) this month [END SURVEY]
- B) within the last 3 months [Continue Survey]
- C) within the last 6 months [Continue Survey]
- D) more than 6 months ago [Continue Survey]
- E) Not Applicable [Continue Survey]

### BOAT ANGLERS ONLY: Did you fish or are you fishing in San Diego Bay?

- Yes    [Continue Survey]  
No     [END SURVEY]

- 3) What is your zip code?
- 4) Do you, family or friends eat the fish that you catch from San Diego Bay?  
Yes                      No
- 5) Would you be willing to complete a survey right now?  
Yes                      No

If **yes** the following are asked on site – or a paper version is provided with a SASE for return.

-----

- 1) On average how many times a week do you come here to fish? (please check one)  
☐ Less than one time a week                      ☐ Three times a week  
☐ One time a week                                      ☐ Four to five times a week  
☐ Two times a week                                      ☐ More than five times a week
- 2) Which time of year are you most likely to be fishing here? (please check one)  
☐ Fall (Sept-Nov)                                      ☐ Summer (June-August)  
☐ Winter (Dec-Feb)                                      ☐ All seasons  
☐ Spring (March-May)
- 3) What types of fish have you caught and kept for yourself, or someone else, to eat this week in San Diego Bay? (please list)

\_\_\_\_\_

\_\_\_\_\_

- 4) Of the fish you catch from San Diego Bay, what size portion do you or others you share fish with typically eat for a meal? (please check one)

☐ 1.5 oz. ☐ 7.5 oz.  
☐ 3.0 oz. ☐ Other \_\_\_\_\_  
☐ 4.5 oz. ☐ Not Applicable  
☐ 6.0 oz.

- 5) How are the fish typically prepared? (please check one)

☐ Boiled ☐ Baked  
☐ Fried ☐ Grilled  
☐ Blended to make a paste (cold) ☐ Other \_\_\_\_\_  
in the blender ☐ Not Applicable  
☐ Make jerky

- 6) What portion of the fish do you eat?

☐ Filet only ☐ Other \_\_\_\_\_  
☐ Whole fish

- 7) What is the most common language that is spoken in your home? \_\_\_\_\_

- 8) What types of fish do you catch when you are fishing in San Diego Bay? (please list)

\_\_\_\_\_  
\_\_\_\_\_

- 9) Who else eats the fish that you catch in San Diego Bay? (please choose all that apply)

☐ Family ☐ Other \_\_\_\_\_  
☐ Friends ☐ No one else eats the fish that I catch  
☐ Neighbors

- 10) How many children eat the fish that you catch from San Diego Bay?  
(please insert a number) \_\_\_\_\_

- 11) How many meals a week do you or your family eat from fish that you caught in San Diego Bay? (please check one)

☐ None ☐ Four to five meals a week  
☐ One meal a week ☐ More than five meals a week  
☐ Two to three meals a week

- 12) In the last 30 days, how many meals have you or your family eaten from fish that you caught in San Diego Bay? (please insert a number) \_\_\_\_\_

- 13) What form of transportation did you take to get to your fishing spot on San Diego Bay? (please check all that apply)
- |                               |                                      |
|-------------------------------|--------------------------------------|
| <input type="checkbox"/> Car  | <input type="checkbox"/> Bike        |
| <input type="checkbox"/> Bus  | <input type="checkbox"/> Train       |
| <input type="checkbox"/> Walk | <input type="checkbox"/> Other _____ |
- 14) How many years have you lived in the San Diego region? (please check one)
- |                                      |   |
|--------------------------------------|---|
| <input type="checkbox"/> Less than 5 | <input type="checkbox"/> More than 20             |
| <input type="checkbox"/> 6 - 10      | <input type="checkbox"/> I don't live in the area |
| <input type="checkbox"/> 11 - 20     |   |
- 15) Where else do you like to catch fish in the local area? (please check all that apply)
- |   |                                      |
|---|--------------------------------------|
| <input type="checkbox"/> Northern San Diego Bay | <input type="checkbox"/> Ocean       |
| <input type="checkbox"/> Middle San Diego Bay   | <input type="checkbox"/> None        |
| <input type="checkbox"/> Southern San Diego Bay | <input type="checkbox"/> Other _____ |
| <input type="checkbox"/> Mission Bay            |                                      |
- 16) Do you live more or less than 25 miles from San Diego Bay? (please check one)
- |   |   |
|---|---|
| <input type="checkbox"/> Less than 25 miles | <input type="checkbox"/> More than 25 miles |
|---|---|
- 17) Are you aware of any fish advisories regarding fish consumed from San Diego Bay? (please check one)
- |                              |                             |
|------------------------------|-----------------------------|
| <input type="checkbox"/> Yes | <input type="checkbox"/> No |
|------------------------------|-----------------------------|
- 18) How do you categorize your ethnicity? \_\_\_\_\_
- 19) In what year were you born? \_\_\_\_\_
- 20) What town do you live in? \_\_\_\_\_
- 21) Do you have a smartphone? (please check one)
- |                              |
|------------------------------|
| <input type="checkbox"/> Yes |
| <input type="checkbox"/> No  |